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ABSTRACT

This guide is activity oriented and designed to provide environmental experiences for children in grades four through six which will involve them in making value judgments relative to their own community. Content covers problems dealing with air pollution, water pollution, solid wastes, and the aesthetics of visual pollution. Five to fourteen lessons are suggested for each major area indicating the individual topic to be studied, aim of the lesson, approach or key questions, outline (of information), activities, and resource materials. Diagrams, charts, and maps are drawn when appropriate. The material may be used independently or integrated into the existing curriculum. This work was prepared under an ESEA Title III contract for Project Outreach, Phoenix, Arizona. (BL)

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ENVIRONMENTAL EDUCATION

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ESEA TITLE III
PROJECT OUTREACH

Funded Through

PHOENIX UNION HIGH SCHOOL SYSTEM
Phoenix, Arizona

SE 016 608

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Teaching Environmental Pollution

Grades 4 - 6

Prepared by

Project Outreach

An Environmental Education Program

of the

Phoenix Union High School System

Phoenix, Arizona

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To the teacher .....

This guide is activity oriented and designed to provide environmental experiences for children which will involve them in making value judgements relative to their own community. Problems dealing with air, water, solid wastes, and aesthetics is the content of this guide.

This material may be used independently or integrated into the existing curriculum. It provides daily lesson plans and activities that may be used in or out of the classroom. The use of inquiry questions and student interaction do not necessarily have to precede the activity for each lesson.

Teachers are encouraged to use this material in any manner that will aid them in the classroom.

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WATER POLLUTION

Lesson 1: The Importance of Water to Living Things.

Aim:

The importance of water to all living things is unquestionable. Water is a liquid we use everyday of our life, but yet we often take it for granted. But, can we afford to take it for granted? This discussion is designed to reveal the importance of water as a natural resource to man.

Approach:

1. What liquids are important to living things?
2. Where did the very first water come from?
3. How did water become so plentiful?
4. How would you prove ice is heavier or lighter than water?
5. Why is it important that ice be heavier than water? (Fish would die if lake froze solid.)
6. How would you describe water to a friend?
7. What other liquids could do about the same things as water?
8. If it were to stop raining for ten years, what could you predict would happen?
9. How could you prove to a friend water is important to living things?
10. How would a scientist define water?

Outline: An introduction to water

A. Origin of water
   1. Juvenile origin
      a. formed by chemical reactions within the earth
      b. explosions and fire occurred during birth of water
      c. pure water from the sky
   2. Rain cycle (endless circulation)
      a. hot air rises, cools, falls as precipitation

B. Discovery of water
   1. Thales (595 B.C.)
      proposed water, the primary source of all living things
   2. Cavendish and Priestly
      credited with discoveries of hydrogen and oxygen, respectively
   3. Lavoisier
      discovered the true nature of combustion

C. Properties of water
   1. colorless, transparent liquid
   2. compound of two gases, hydrogen and oxygen
   3. can exist in three phases: liquid, solid, gas
   4. high surface tension (float a paperclip on)
   5. high specific heat
   6. universal solvent

Activity:

1. Give containers (paper cups, test tubes, etc.) to each student. Fill each container with water. Secretly put distilled water in one; salt water in another; and sugar water in a third. Know which students will have these cups. Use data sheet for further instructions.

"What Is Water?" You have been given a container of water. Do not taste the water until you are told to do so.

1. What is the color of the water?
2. If water is a liquid, how could you prove it?
3. Touch the water. Describe this feeling.
4. Blow on the back of your hand. Describe this feeling.
5. Smear some water of the back of your hand. Blow again on your hand. Describe what you felt.
6. Do you think a piece of metal such as a paper clip would float on your water? Explain.
7. Take a paper clip and carefully place it on your water. It will float. Describe what you see.
8. Without tasting your water, describe its taste.
9. Describe what you think polluted water looks like.
10. Taste your water and then fill in the blanks.
    Is your water:

a. sweet _____		e. bitter _____	
b. sour _____		f. flat _____	
c. chalky _____		g. oily _____	
d. salty _____		h. _____ _____	

Resource Materials:

Film, "What in the World Is Water?" from Project Outreach or McGraw-Hill Films. 16mm/12 mins./color

Lesson 2: To Expand Lesson 1.

Aim:

We see our water as rain, frozen as ice cubes, or as streams, rivers, lakes, and great oceans. But, water is also somewhere else that one would never suspect. It is in the air we breathe. This discussion is designed to broaden the concept of water as an important natural resource.

Approach:

1. Where is water found?
2. Name a plant that has a great deal of water in it.
3. Why is it important that soil have water?
4. Describe the type of organism that would live in water. Is there more than one kind of organism that lives in water?
5. How is evaporation of water important to the amount of rain that falls?

6. Why are the leeward sides of mountains usually dry?
7. Is water in the air? Explain.
8. How do trees take in water?
9. Do trees lose water into the air?
10. Why do humans need water?

Outline: Where does our water come from?

A. Sources of our water
   1. hydrologic cycle (the water cycle)
      combined work of the sun, air, water, and gravity
   2. precipitation
      rain, snow, sleet, hail, from the clouds
   3. evaporation
      ponds, lakes, streams, oceans, seas, plants

B. Importance to living things
   1. the soil will not produce without water
   2. home to aquatic life
   3. for food (fish)
   4. for health
   5. regulates body temperature, nourishes tissue

Activity:

1. Hold a drinking glass over a flame. Do not allow the glass to touch the flame. The candle will eventually go out because it has exhausted the air supply for combustion. Notice the moisture inside the glass. Touch it. Hydrogen in the candle flame, combined with oxygen in the air to make water.

2. Give a sheet of paper to each of your students. Type on the sheet the following: "Do not tell anyone your question. When you are called upon, give only your answer."

   Question: Can you name something you eat that doesn't have water in it?"

3. Dry your tongue with a clean towel. Put a pinch of sugar on the tip of your tongue. You cannot taste the sugar. Add a few drops of water to the sugar. You will be able to taste it now.

Resource Materials:

Film, "Problems of Conservation: Water" Project Outreach or Encyclopedia Britannica Educational Corporation. 16mm/16 mins./color

Lesson 3: "Water, a Need for Man"

Aim:

The water cycle is a perpetual circulation system. Water is stored in the soil, in the vegetation, or in the atmosphere.

Winds carry water which evaporate from the soil, the plants, lakes, rivers, seas and oceans. This moisture may condense and precipitate as rain, hail, and snow. Some of the precipitation is re-evaporated back into the air to become part of the atmosphere moisture. Man depends upon the water cycle for his needs. This Lesson will show the importance of water to man.

Approach:

1. Can you predict it will rain?
2. Where does the water for our streams and rivers come from?
3. Where does the most rain fall in Arizona?
4. What does heat do to water?
5. What does cold do to water?
6. How much water is in a large, white cloud? (over 1000 tons of moisture)
7. Describe the kinds of plants that live on a river bank and those that live in a dry, desert wash.
8. What causes the shapes of clouds? (rising air, wind)
9. Predict what would happen if you poured a gallon of water from a high flying aircraft.
10. How do you use water at home?

Outline: Water, a need for Man.*

A. Domestic use
   1. 1900, amounted to 3 billion gallons daily in U.S.
   2. 1960, 22 billion gallons daily
   3. 1980, estimated 37 billion gallons
   4. at home: recreation, health, washing, waste removal, lawn care
   5. municipalities: recreation, fire fighting, street washing

B. Industrial use
   1. 1900, amounted to 15 billion gallons daily
   2. 1960, 160 billion gallons daily
   3. 1980, estimated 394 billion gallons
   4. industrial uses: cleansing, cooling, power, mining

C. Irrigation
   1. 1900, amounted to 22 billion gallons daily
   2. 1960, 141 billion gallons daily
   3. 1980, estimated 166 billion gallons
   4. Plants use large quantities of water
      e.g. wheat plants use 500 pounds of water for each pound of dry matter
      e.g. bushel of corn requires 10,000 gallons of water
   5. reclamation of the land
      a. excess water--land reclaimed by drainage
      b. dry land-land reclaimed by irrigation
   6. leaching of the soil
      removal of unwanted chemicals

*1001 Questions Answered About Water Resources, Floyd Cunningham; Dodd, Mead, & Company

D. The watershed (drainage area)
   1. drainage area, water drains toward a single stream or river
   2. disposes of water to stream flow
   3. water that falls to the earth
      a. run-off (the watershed)
      b. held-in or penetrates through soil
   4. serves as a social and economic unit

Activity:

1. Take daily observations and recordings of your water meter at home.

2. Monitor a water meter at a car wash (preferably a car wash that doesn't recycle it's rinse water)

3. Demonstrate evaporation. Use two identical glasses. Put ½ cup of water in one. Invert the empty one over the other. Seal with masking tape. Predict the results.

Resource Material:

Film, "The Seashore" from Project Outreach or Arthur Barr Productions, Inc. 16mm/10 mins./color

Lesson 4: Arizona Water

Aim:

The conservation of water in Arizona is of prime importance. Since most of our populace lives in the desert region, the water must be transported from another area to meet our needs. The population of Arizona is increasing at a tremendous rate. This increases water usage, particularly with heavy industry. A natural system of water delivery will be unable to meet the the demands of an expanding population. We need to find a quick and practicable way of transporting water into the populated areas. Lesson 4 will show the sources and problems of Arizona water.

Approach:

1. Why does our water taste differently throughout the state?
2. Why is our water harder some years and not others?
3. How much does our water cost?
4. Where do we obtain our water?
5. How does the climate of the Southern Pacific Coast affect rainfall in Arizona?
6. Which has more moisture in the air: the deserts of Southern Arizona or a Pacific rain forest? (the former)
7. Why does it snow more in Flagstaff than in Phoenix?
8. Why is water important to the people of Arizona?
9. If Arizona can't obtain water within ts boundaries, how would you suggest we obtain it?
10. Predict what would happen if Arizona's water supply were to be cut in half.

EXISTING AND PROPOSED DAM SITES

IN THE CENTRAL ARIZONA PROJECT

Outline: Arizona Water

A. Source of Arizona Water
   1. interstate rivers (Verde River, Salt River, Gila River, Williams River, etc.)
   2. man-made lakes
   3. out-of-state rivers (parts of the Colorado River and Virgin River)
   4. rain and snowfall
   5. watersheds
   6. cloud seeding

B. Problems of Arizona Water
   1. increased usage for domestic purposes
   2. high flouride content in some waters (i.e. Gila River)
   3. watershed management
   4. Phreatophyte control
   5. water delivery
   6. pumping from great depths
   7. droughts
   8. mis-use
      a. domestic (artificial lakes versus needs of the total population)
      b. industrial (using water to wash parking lots, sidewalks, and walls)
      c. agricultural (irrigating lands low in nutrients that will not yield a productive crop)

Activity:

1. Using an Arizona map, devise a system of delivery that would increase our water supply (alluding to the Central Arizona Project).

2. Go outside and draw clouds. The class is to be divided into four groups. One group will draw the clouds of the Southern Sky, another the Eastern Sky, etc. Look for shapes and designs within the clouds. Do this activity early in the morning and in the afternoon. Compare drawings. Display them on the north, south, east, and west walls of the classroom.

3. "You as a raindrop" Ask students to make one act plays about a raindrop. Using an Arizona or community map, assign areas that each raindrop (student) will fall.

Resource Material:

SO17 Water Conservation Slides from Project Outreach.

Lesson 5: Maricopa County Water

Aim:

Maricopa County receives about 7 to 11 inches of water a year. Most of this is lost by evaporation and plant transpiration.

Industrial growth within the country is increasing at such a rapid rate that we cannot afford to waste water; therefore, the wise use of water by industry and the public is essential to avoid a major water shortage. Lesson 5 will show the sources and problems of Maricopa County water.

Approach:

1. What ways does Maricopa County obtain its water?
2. What kind of climate increases water evaporation?
3. How could a farmer conserve water?
4. How do we waste water without really knowing we are?
5. What time of the year do we use the most water?
6. How would a farmer remove unnecessary minerals from his soil?
7. What are some ways man can conserve water?
8. How can water be harmful to agriculture?
9. What area has the most industry in Arizona?
10. What type of plants use great amounts of water?

Outline: Maricopa County Water (outline adapted from "Utilization of Water in the Central Area of Arizona" by W.H. Fuller and W.S. Gookin)

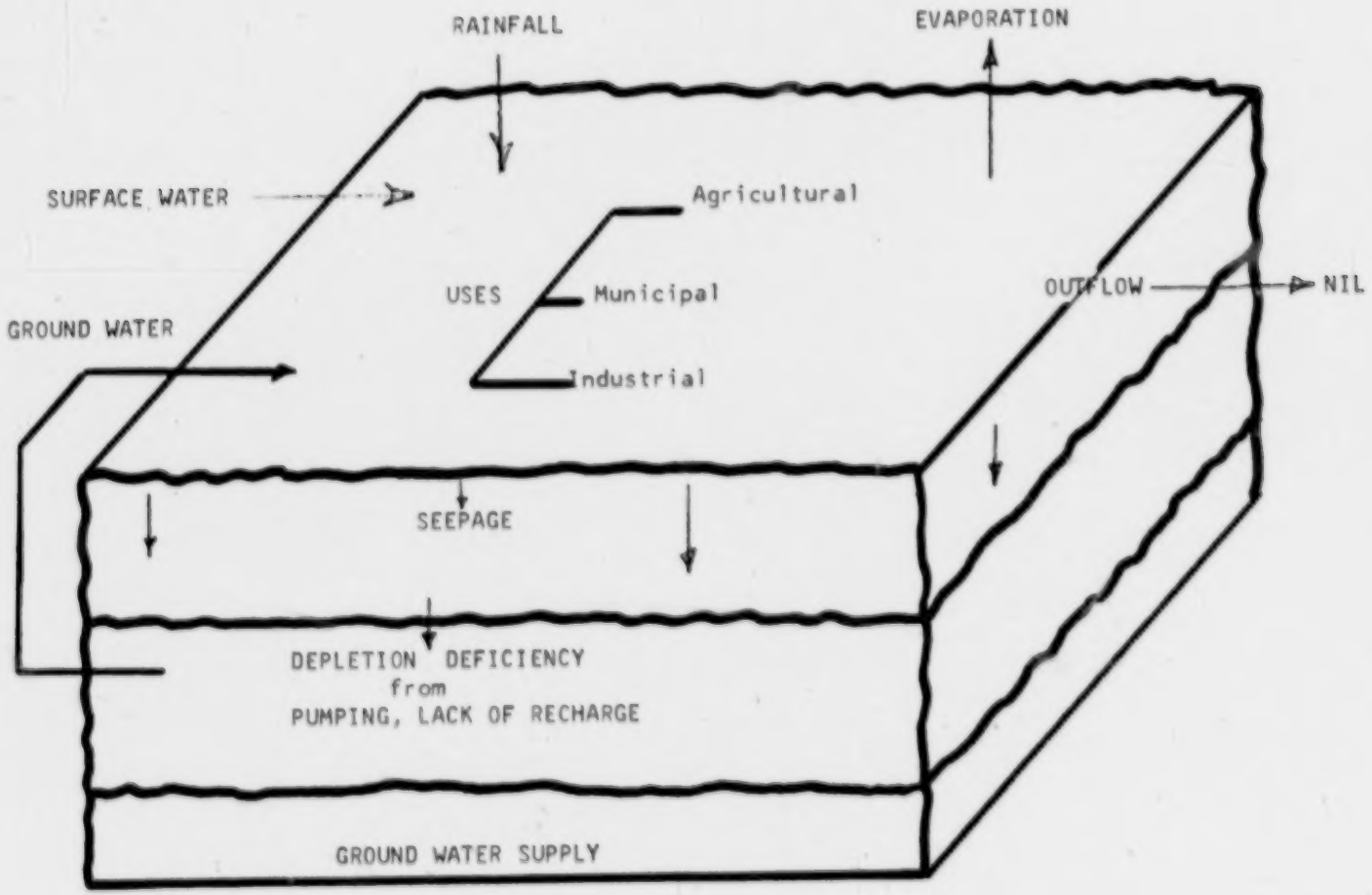
A. Source of Maricopa County Water
   1. Precipitation (mainly rainfall)
      a. late summer and mid-winter rainfall
      b. approximately 7-11 inches
      c. most lost by evaporation and transpiration
   2. Surface water
      a. approximately 778,800 acre feet diverted
      b. stream flow completely utilized
   3. Groundwater
      a. approximately 2,430,000 A.F. diverted
      b. varied and dependent upon geology of the region

B. Uses
   1. Agricultural
      a. farmers forced to wise-use patterns due to lack of available water
      b. leaching - important to keep salts moving down past vital root zone
      c. approximately 1,562,500 A.F.
   2. Municipal and industrial
      a. acute shortage, high cost
      b. approximately 198,000 A.F.

C. Recovery - most of Maricopa County's water is recovered.

D. Problems
   1. abundance of good land and a shortage of water
   2. high cost of pumping groundwater
   3. lowering of groundwater level
   4. farm ditches need lining
   5. good management of soil, water, crops, and watersheds
   6. careful metering of water for industrial and municipal use
   7. implementation of the Colorado River water into the Central Arizona area.
   8. transpiration--non-beneficial vegetation transpires water into the air

SIMPLIFIED MODEL OF THE WATER CYCLE IN CENTRAL ARIZONA



9. evaporation
10. farmers must use more water than necessary due to evaporation, transpiration, and seepage.

Activity:

"Your Glass of Water." Each student is given four cups. One cup is filled with water. The student is to write where he wants his water to come from (groundwater, surface water, or precipitation). The remaining three cups are labeled: agricultural, municipal and industrial.

Have the students approximate a proportional amount of water used for each respective category in Maricopa County. Pour the approximate amount from the first cup into each respective cup. Have three empty gallon jars also labeled: agricultural, industrial, and municipal. When the students have completed their pouring, tell them to pour their water into each respective gallon jar. (Agriculture in Maricopa County uses more than seven times as much water than municipal and industrial combined.)

Resource Material:

Film, "Life in Parched Lands" from Project Outreach or McGraw-Hill Films 16mm/30 mins./color

Lesson 6: Phoenix Water

Aim:

It is projected the population of Phoenix will be over 1,200,000 persons by the year 2000. Already the city of Phoenix is making plans for the population increase. Where will we obtain the water for this population? Perhaps by looking at the present water system, one can see the immensity of the problem of obtaining water for Phoenix.

Approach:

1. What time of the year does Phoenix use the most water? Explain.
2. What is water used for in Phoenix?
3. Estimate the amount of water used in one day in Phoenix.
4. How have you seen water wasted in Phoenix?
5. Why do we need to filter our water?
6. Do we use our water directly from the filter plant or is it stored first?
7. Where is water stored in Phoenix?
8. Why is it unfeasible to entirely rely on well water for Phoenix?
9. Why is it important to take readings of the amount of snow that falls in Arizona?
10. How is water used for recreation in Phoenix?

Outline: Phoenix Water System

A. Source
   1. Surface water from Salt and Verde Rivers
   2. 77 wells in Phoenix area

B. Quality
   1. Varies with amount of snow and rain
   2. A high run-off will yield a softer water.

C. Production capacity
   1. Verde Water Treatment Plant - 49 million gallons daily (MGD)
   2. Squaw Peak Water Treatment Plan - 110 MGD
   3. Deer Valley Water Treatment Plan - 80 MGD
   4. Well supply - BS MGD

D. Water demand
   1. Average person in U.S. will use 17 gallons daily.
   2. 129.5 MGD sold daily in Phoenix

E. Uses of Phoenix water
   1. Agricultural - irrigation
   2. Industrial - factories, warehouses, stores, car washes.
   3. Municipal - home owners, clean streets, fire fighting recreation

F. Mis-use of Phoenix water
   1. washing sidewalks and driveways
   2. irrigation overflow
   3. car washes without rinse water recycling devices
   4. using well water for artificial lakes

G. Future Outlook
   1. use of treated effluent could possibly be used to water golf courses, lawns, and gardens
   2. water recycling systems for pools and car washes
   3. building of the Central Arizona Project
   4. more means and ways to economically secure more water

Activity:

1. Observation and recording of the home water meter. Determine peak hours.

2. Phoenix has approximately 2,900 miles of water pipeline. Use this figure to show how far the pipes could reach if put end to end beginning at a student's home.

3. Have students design their own water treatment plant.

4. Arrange a tour to one of the city's water treatment plants.

5. Design a bumper sticker using the theme, "Conserve Phoenix Water."

Resource Material:

Film, "The Problem with Water is People" Project Outreach or McGraw-Hill Films 16mm/30 mins./color

TEN YEAR REVIEW OF SIGNIFICANT WATER SYSTEM STATISTICS *

	Item of Record	Increase 1962 - 1971	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
DISTRIBUTION SYSTEM	Est. Population Served (3.6 x No. Service Conn.)	33%	632,927	612,600	584,800	561,200	553,000	542,000	536,000	530,000	520,000	477,000
	Total Service Connections[1]	34%	175,813	170,165	162,433	155,999	153,720	150,173	146,651	145,096	142,467	130,879
	Active Services . . . Inside City Limits	23%	148,043	142,576	138,295	131,497	129,892	128,455	124,991	133,156[1]	131,356[1]	120,374[1]
	Active Services . . . Outside City Limits	46%	15,360	14,404	13,192	12,829	12,507	12,338	11,561	11,940[1]	11,081[1]	10,505[1]
	Service Area (Square Miles)	47%	260.7	252.5	234.5	212	212	212	185	185	185	177
	Miles of Water Mains	35%	2,861	2,779	2,672	2,577	2,546	2,508	2,412	2,365	2,300	2,123
	Fire Hydrants in Service	110%	12,433	11,733	10,960	10,381	9,894	9,409	8,755	7,740	6,898	5,919
PRODUCTION CAPACITY	Verde Water Treatment Plant (MGD)	—	40	40	40	40	40	40	40	40	40	40
	Squaw Peak Water Treatment Plant (MGD)	22%	110	110	110	110	110	110	110	110	90	90
	Deer Valley Water Treatment Plant (MGD)	—	80	80	80	80	80	80	80	0	0	0
	Well Supply - Rated Capacity (MGD)	17%	135	130	120	120	116	116	111	115	115	115
	Total Water Production Capacity (MGD)	47%	365	360	350	350	346	346	341	265	245	245
	Storage Reservoir Capacity (MG)	72%	192	193	191	171	169.5	163.5	163.5	142.5	112	112
WATER DEMAND	Average Daily Delivery to Water System (MGD)	57%	144.5	142.1	125.7	120.8	116.8	117.1	102.3	108.7	107.9	91.9
	Average Daily Delivery - Well Water (MGD)	53%	48.2	45.7	43.4	38.3	44.9	43.6	40.7	44.1	41.8	31.4
	Average Daily Delivery - Surface Water (MGD)[2]	59%	96.3	96.4	82.3	82.5	71.9	73.5	61.6	64.6	66.1	60.5
	Maximum Daily Delivery to Water System (MGD)	44%	272.0	265.2	228.9	222.7	231.2	221.7	217.5	214.8	201.1	189.3
	Minimum Daily Delivery to Water System (MGD)	78%	63.1	63.5	53.5	52.7	51.8	46.9	43.1	49.1	43.4	35.4
	Peak Water Demand Rate - Single Hour (MGD)	34%	356.0	338	320	333	333	307	312	305	293	265
	Average Daily Water Sold (MG)	52%	129.5	126.2	112.7	106.8	108.1	112.9	95.3	101.8	101.5	85.2
	Average Per Capita Water Demand (gallons per day)	—	228.0	232	215	215	211	214	191	205	208	193
	Total Rainfall for Fiscal Year (Inches)	—	5.77	6.50	7.24	9.49	6.77	9.11	11.24	7.08	3.59	6.43
	Rainfall (April thru September - Inches)	—	4.48	2.53	2.58	1.14	4.86	1.16	6.11	2.81	1.07	2.85

* City of Phoenix, Water and Sewers Department, Phoenix, Arizona

WATER SYSTEM

SIGNIFICANT WATER STATISTICS*

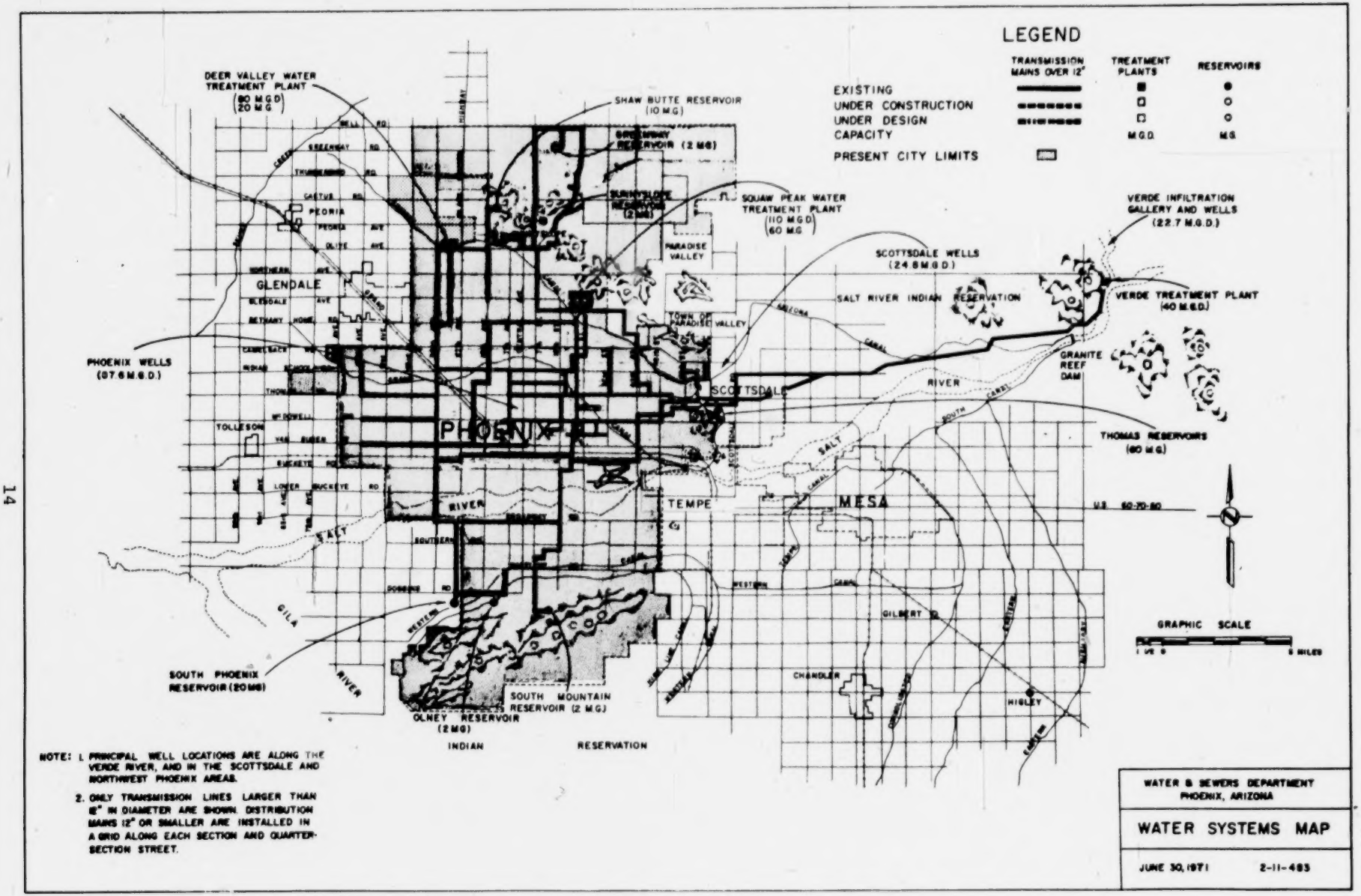
Fiscal Year Ended June 30, 1971
with Comparative Figures for 1970

	1971	1970
Service Connections		
Total number of services	175,813	170,165
Active services inside city	148,043	142,576
Active services outside city	15,360	14,404
Inactive services	12,410	13,185
Production (Gallons)		
Verde Infiltration Gallery	1,655,395,000	2,250,853,000
Verde River Wells	6,040,680,000	4,830,499,000
Scottsdale Wells	6,156,717,000	5,956,393,000
Phoenix Area Wells	11,418,161,000	10,611,448,000
Verde Water Treatment Plant	5,648,575,000	5,157,605,000
Squaw Peak Water Treatment Plant	10,865,727,000	14,015,548,000
Deer Valley Water Treatment Plant	10,942,241,000	9,056,211,000
Total Water Produced	52,727,496,000	51,878,557,000
Adjustment for water in storage	+ 10,800,000	- 11,900,000
Delivered to Water System (Gallons)		
Total delivered to water system	52,738,296,000	51,866,657,000
Average daily delivery to water system	144,488,000	142,100,000
Maximum daily delivery to water system	271,956,000	265,206,000
Minimum daily delivery to water system	63,072,000	63,482,000
Water Sold (Gallons)		
Total Water Sold	47,254,900,000	46,053,667,000
Average daily water sold	129,465,000	126,174,000

CLIMATOLOGICAL DATA

Total Rainfall, July 1, 1970 - June 30, 1971	5.77 Inches
Average Yearly Rainfall - Past 25 years	7.21 Inches
Maximum Mean Temperature, July 1, 1970 - June 30, 1971	85.1 Degrees
Minimum Mean Temperature, July 1, 1970 - June 30, 1971	56.5 Degrees
Long-Term Mean Temperature - Past 30 Years	69.6 Degrees

*City of Phoenix, Water and Sewers Department, Phoenix, Arizona



NOTE: 1. PRINCIPAL WELL LOCATIONS ARE ALONG THE VERDE RIVER, AND IN THE SCOTTSDALE AND NORTHWEST PHOENIX AREAS.

2. ONLY TRANSMISSION LINES LARGER THAN 12" IN DIAMETER ARE SHOWN. DISTRIBUTION MAINS 12" OR SMALLER ARE INSTALLED IN A GRID ALONG EACH SECTION AND QUARTER-SECTION STREET.

WATER & SEWERS DEPARTMENT
PHOENIX, ARIZONA

WATER SYSTEMS MAP

JUNE 30, 1971 2-11-483

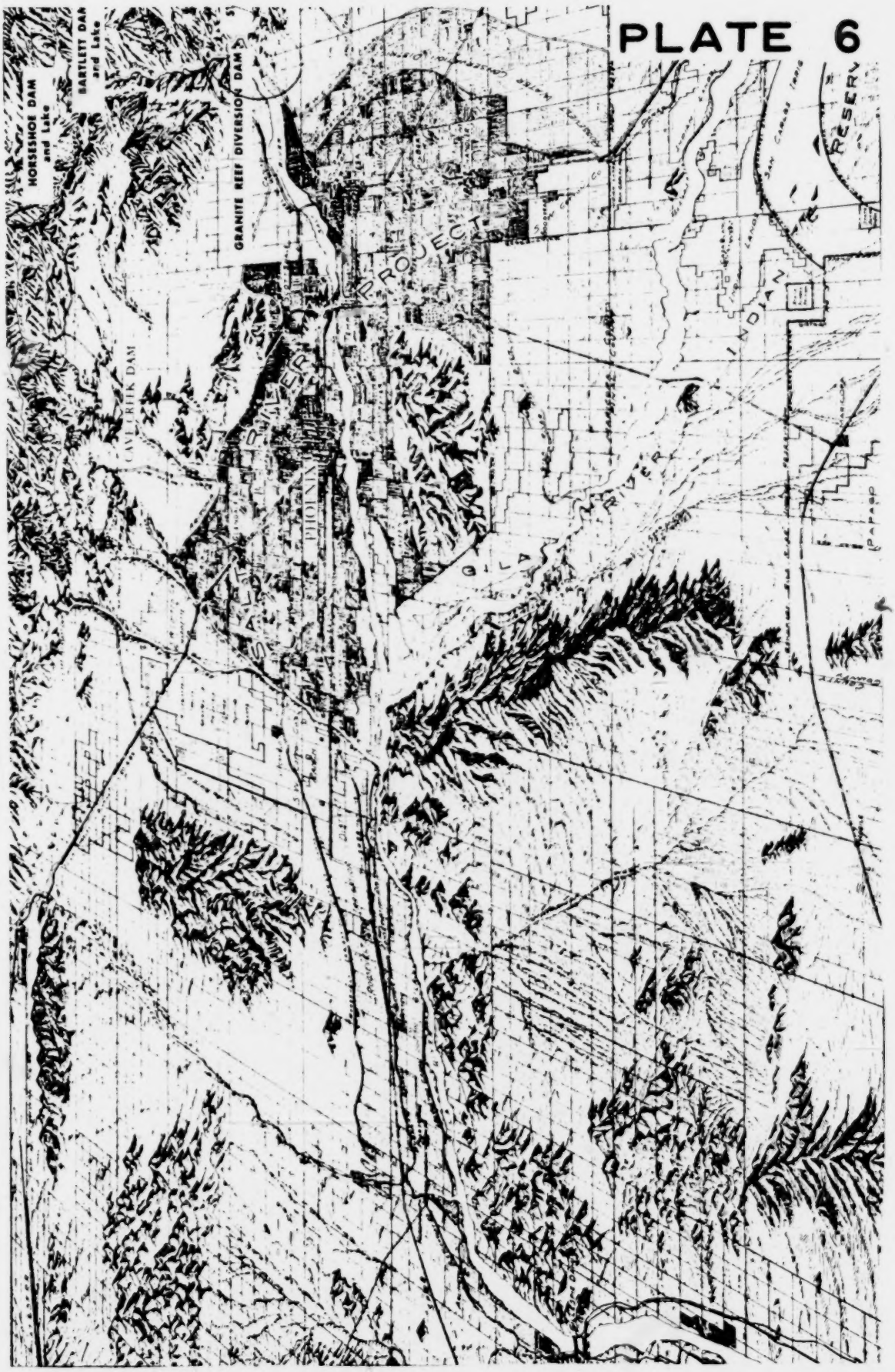


PLATE 6
HORSESHOE DAM and Lake
BARTLETT DAM and Lake
GRANITE REEF DIVERSION DAM
CAVE BUTTE DAM
PAPAGO

Lesson 7: Lakes and Rivers of Arizona

Aim: Water in Arizona rivers do not always flow. The San Carlos River drains an area of 1,027 square miles and averages 32,070 acre-feet per year, but yet there are periods of no flow at all. Fortunately, we do have a few rivers that do flow continually and contribute to our essential water supply.

Lakes, for the most part, are the result of man-made dams. Bartlett Lake, Horseshoe Lake, Canyon Lake, Mormon Lake are a few.

The complexity of the drainage into Arizona's Lakes and rivers is beyond the scope of this curriculum. Therefore, this particular lesson will rely more on student and teacher interaction.

Approach:

1. Why are lakes important to Arizona's water supply?
2. Where does the water come from for our rivers?
3. When does the flow of water in our rivers increase?
4. Why are some rivers dry most of the year?
5. How did aquatic plants first get into our lakes and rivers?
6. What living things depend upon the water of a lake or river?
7. Why does the temperature of the water drop as you go deeper?
8. Are lakes and rivers always surrounded by mountains? Explain.
9. What advantage are mountains to the water supply of a river or lake?
10. How could water recreation affect the quality of a river or lake?

Outline: Lakes and Rivers of Arizona

1. Lakes
   - A. Characteristics
     1. relatively still waters
     2. penetration of light dependent on depth and suspended solids
     3. temperatures vary seasonally and with depths
     4. surface in contact with air
     5. decomposition occurs at the bottom
     6. oxygen content is low (still water)
   - B. As a valuable resource
     1. Lakes can regulate the flow of rivers to benefit man
     2. recreation
     3. water storage
     4. development of electrical power
     5. irrigation
   - C. Arizona lakes
     1. Many are man-made (Mead, Mary, Pleasant)

2. Largest Arizona lakes make up Salt River System.
3. Serve Arizona for irrigation, municipal, industrial, and recreational use.

2. Rivers
   A. Characteristics
      1. Rivers or streams are a continuously moving body of water within a channel.
      2. Rivers may be outlets of lakes or the result of watershed drainage.
      3. Steep downhill movement causes debris to cut a channel wider and deeper.
   B. As a valuable resource
      1. recreation
      2. Waters from watersheds flow into rivers
      3. home for aquatic organisms
   C. Arizona rivers
      1. greatly affected by rainfall
      2. many rivers rarely flow
      3. sediment load is high for many rivers
      4. many rivers becoming polluted due to increased usage
      5. many have high mineral content

Activity:

1. Using a map of the Salt River Drainage Area (see watershed lesson), ask students to color in the lakes and rivers which make up the Salt River Project.

2. Arrange a tour of the Salt River Project.

3. Have the student look at an Arizona highway map with elevations. Determine the reasons behind our waters having a high mineral content.

Resource Material:

Film, "Our Environment, Part I" Project Outreach

Lesson 8: Importance of Water to Living Things

Aim:

We are dependent for water primarily for survival. Water is in every living cell of our body. It is essential to the body chemistry. It acts as a thermostat to maintain our body's temperature. Lesson 8 will show the importance of water to living things.

Approach:

1. Name something living that doesn't have water in it.
2. Where do we obtain the water we drink?
3. Name something you eat that doesn't have water in it.

4. How do you use water?
5. Name a living thing that doesn't have to look for water survival.
6. If you were a land animal, how would you go about looking for water?
7. Man must deliver his water from natural sources. How do plants and animals obtain their water?
8. Do aquatic plants and animals always live in pure water?
9. If you were stranded on the high seas and had no water, what would you drink? Explain.
10. How much water should a living thing use?

Outline: Importance of water to living things

A. Living matter
   1. Water makes up a great deal of the matter within an organism.
   2. Maintains life's processes
      a. solvent for body chemicals
      b. thermostat
      c. aids in digestion
      d. nourishes tissues
      e. lubricates tissue to protect from injury

B. Water for man
   1. 97.2% of the earth's water is unfit to drink and too salty for irrigation.
   2. 2% of the water on the earth is frozen as glaciers and ice caps.
   3. .8% of the earth's water is available for drinking.
   4. Man must rely on precipitation and underground water for his needs.

C. Water as a valuable resource to living things
   1. consumption
   2. source of food
   3. oxygen supply
   4. habitat

Activity:

1. You will need six jars for this activity. Baby food jars are ideal. Obtain some dry leaves and/or dry grass. Put some of the dry organic matter in two jars half filled with tap water. Cap one jar. Put tap water in two other jars, cap only one. In the remaining two jars, put some dried organic matter in each. Add nothing and cap one. With the aid of a microscope (many students have one today), daily examine the contents of each jar. Eventually microscopic organisms (Protista) will develop in the jars with water and organic matter. Determine how the organisms got there.

2. Obtain some vegetables such as squash, carrots, green beans, and a hand full of pinto beans. Slice all the vegetables. Ask for volunteers to squeeze the water from the sliced vegetables. Next, try to squeeze the water out of the seeds. Why is it important for seeds not to lose their water?

Resource Material:

1. "Let's Explore a Stream" Project Outreach, Catalog.
2. "Will the Gator Glades Survive?" Film; Project Outreach, Catalog.

Lesson 9: The Desert

Aim:

Water is the life blood of all living organisms. The desert organism must often face critical water shortages. Lesson 9 will show the importance of water in the desert and how plants and animals adapt themselves to the desert climate.

Approach:

1. A desert tends to lack any really large animals. Why is this so?
2. Why are there more cacti in a desert than in a forest?
3. Why do most desert animals go underground during the day and come out at night?
4. Why do many desert plants have prickles, thorns, and spines?
5. Why do many desert plants have leathery leaves?
6. Where are insects prevalent in the desert?
7. Some animals in the desert do not sweat. Why?
8. Why do many desert animals have large ears?
9. Why would a desert plant want to store water?
10. Do desert animals store water? Explain.

Outline: Adaptions of plants and animals to the desert

1. The Desert
   - A. Definition of a desert
     1. land evaporation exceeds rainfall
     2. dry, barren region
   - B. Deserts occur in two distinct global belts
     1. approximately about the Tropic of Cancer
     2. approximately about the Tropic of Capricorn
   - C. Formation of the desert
     1. mountain ranges causing a "rain shadow" on leeward sides
     2. poor land management by man
     3. climate, the result of low and high pressure air systems.
2. Desert Plant Life
   - A. Drought evaders
     1. grow when conditions are favorable (moisture, temperature)
     2. persist as seeds, ready to sprout, flower, produce seeds, and die
   - B. Drought resistors (cacti, mesquite, etc.)
     1. can locate underground water
     2. can store water
     3. reduced leaf-size to cut transpiration

C. Adaptions
1. leathery leaves to decrease water loss
2. Light is not a problem, plants must compete for moisture; here they store water
3. rapid germination
4. thorns to protect from enemies

3. Desert Animal Life
A. Drought evaders and adaptations
1. eggs and pupae may lie dormant for several months or several years
2. rains arrive, plants flourish, drought evaders develop
3. rapid maturation
e.g. A. tadpoles into frogs
B. small shrimp develop if rain is sufficient

B. Drought resistors and adaptations
1. restrict activity to cooler parts of the day
2. many nocturnal
3. some live all year without drinking water (e.g. kangeroo rat obtains water from dried seeds)
4. lizards can re-absorb water from their liquid wastes
5. rabbits and other large eared animals radiate heat from their ears
6. ants store food

Activity:

1. Ask some students to bring to class some leaves from desert plants. (Note· Arizona requires a special permit to collect desert plants. Inform your students of this.) Examine the leaves and compare them with other leaves from the vicinity, aquarium plants, and house plants.

2. Heat some soil in a pan. Note the steam rising. Water is trapped in the soil.

3. Enclose a house plant and pot in a plastic bag. Do not allow air to get in or out of the bag. Note the moisture forming on the inside of the bag. Do the same experiment with an empty planter and one filled with soil. (Adapt this experiment to outdoor plants as mulberry trees. Enclose five mulberry tree leaves in a plastic bag. Note the moisture forming on the inside of the bag.)

Resource Material:

Film, "Slow Death of the Desert Water" Project Outreach or National Educational Television Film Service. 16mm/30 mins./color

Lesson 10: Watersheds

Aim:

Lesson 10 will define a watershed and reveal its importance to the water supply of Arizona.

Approach:

1. If you are unfamiliar with the word "watershed", look at it carefully and try to determine what it means.
2. What would you think determines the ability of soil to absorb water?
3. What happens to the water that falls as precipitation?
4. If there is no erosion and if the soil can soak up all the water, can there be too much water?
5. Storing groundwater will not be sufficient in the future. Where will we turn to obtain our water?
6. How can the grazing of livestock affect our water resources?
7. What is water runoff? (Look carefully at the word.)
8. What role do plants play on a watershed?
9. Can there be too much rainfall? Explain.
10. Why do we know more about surface waters than underground water supplies?

Outline: Watersheds in Arizona

1. The Watershed
   - A. What is a watershed?
     1. drainage area
     2. precipitation converted to streamflow
   - B. Secondary uses
     1. lumbering
     2. wildlife production and habitat
     3. recreational use
   - C. Hydrologic alteration of the watershed
     1. destructive logging
     2. overgrazing
     3. fire
     4. processes exposing soil to weathering and erosion
   - D. Arizona watersheds and drainage areas
     1. Colorado River watershed
     2. Gila River watershed
     3. Salt River watershed
   - E. Conservation of watersheds
     1. wise use of land management
     2. care and concern as private citizens
     3. strict laws to prosecute persons who damage watersheds

Activity:

1. Give each student two cups of water. Leave the classroom and go to an area on the playground that has a slanting slope of soil and of grass. Look, also, for an area that is flat, having exposed topsoil and grass. Pour half the water of one cup on the exposed slope.

PLATE 4

GILA RIVER SYSTEM

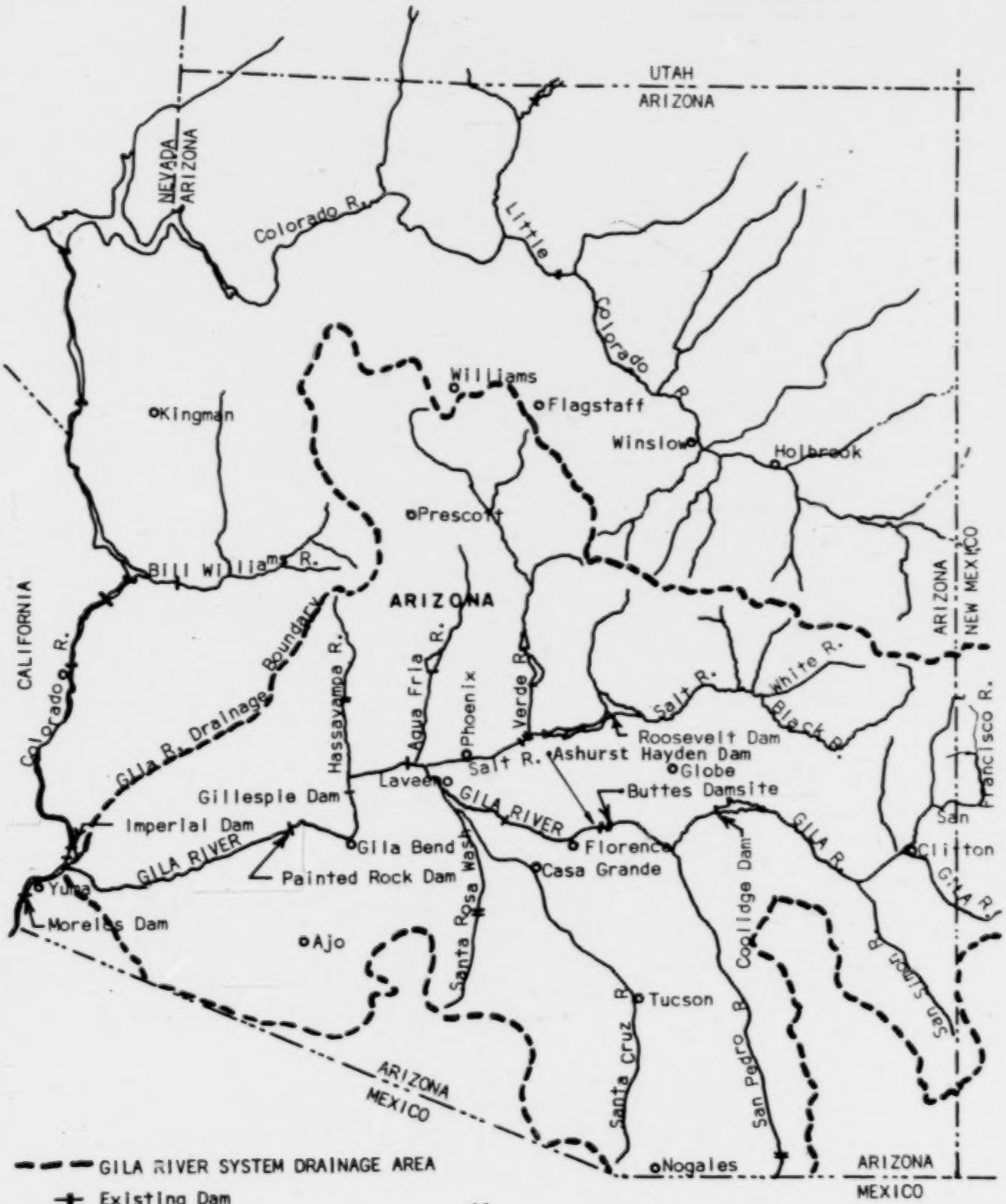
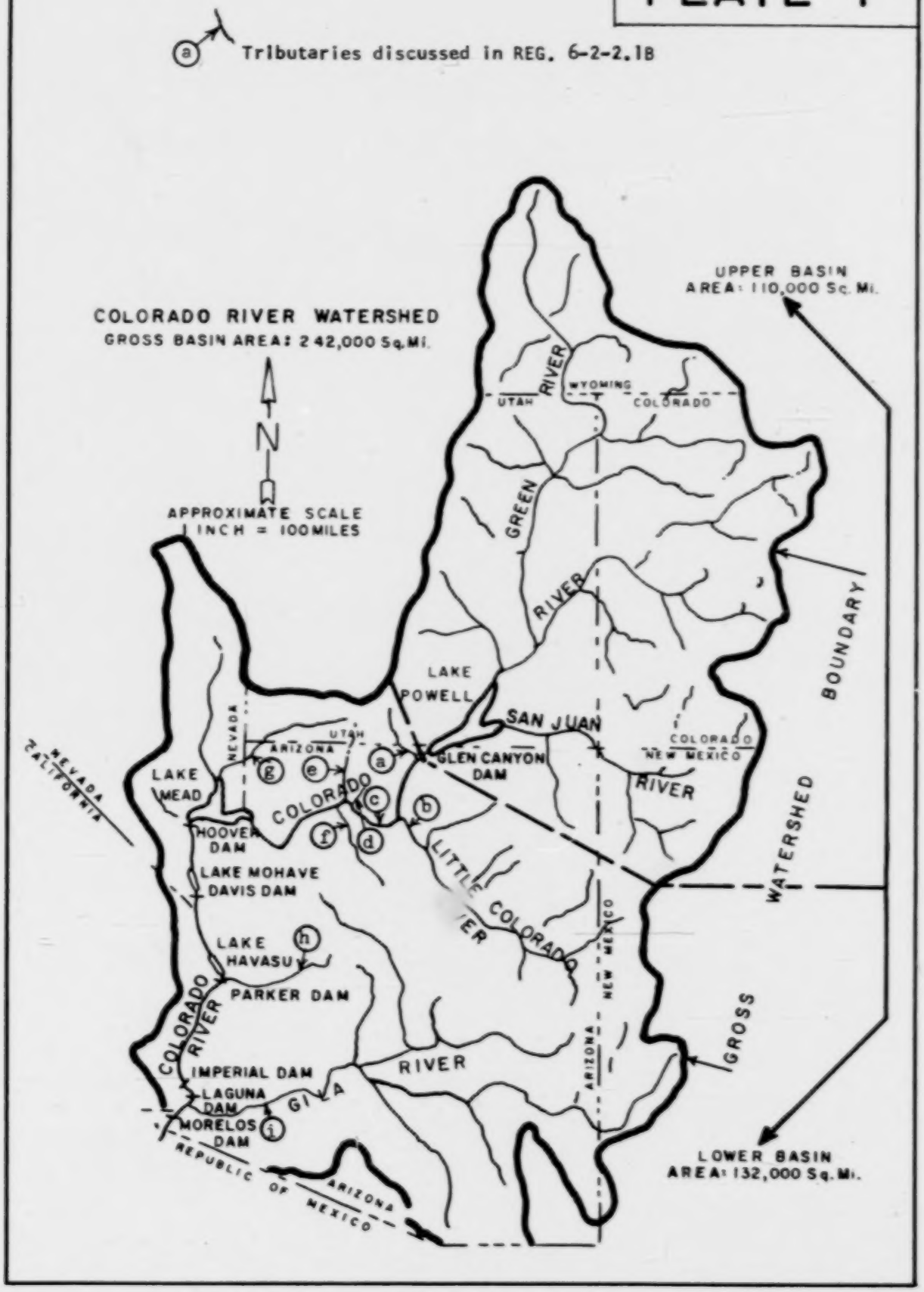


PLATE 1


Tributaries discussed in REG. 6-2-2.18
COLORADO RIVER WATERSHED
GROSS BASIN AREA: 242,000 Sq.Mi.
N
APPROXIMATE SCALE
1 INCH = 100 MILES
UPPER BASIN
AREA: 110,000 Sq. Mi.
UTAH
WYOMING
COLORADO
GREEN RIVER
LAKE POWELL
SAN JUAN
COLORADO
NEW MEXICO
RIVER
BOUNDARY
NEVADA
UTAH
ARIZONA
GLEN CANYON DAM
LAKE MEAD
NEVADA
CALIFORNIA
COLORADO
HOOVER DAM
LAKE MOHAVE
DAVIS DAM
LAKE HAVASU
PARKER DAM
COLORADO RIVER
IMPERIAL DAM
LAGUNA DAM
MORELOS DAM
GILA
RIVER
LITTLE COLORADO
RIVER
ARIZONA
NEW MEXICO
WATERSHED
GROSS
REPUBLIC OF MEXICO
ARIZONA
LOWER BASIN
AREA: 132,000 Sq. Mi.

Observe the results. Do the same with the grassy slope. Observe and compare the results of the slopes. Do the same on the flat area. Discuss with your students the function of a watershed.

2. Design a bumper sticker using the theme: "Conservation of Our Watersheds."

Resource Material:

1. "The Aging of Lakes" Encyclopedia Britannica Educational Corporation or from Project Outreach. 16mm/14 mins./color
2. "Let's Explore a Pond" Filmstrip, Project Outreach.

Lesson 11: Sewage Disposal in Phoenix

Aim:

We must not forget we need to rid our bodies of wastes and poisons. The removal of wastes is a natural biological phenomenon. The removal of waste for a population must be a systematic program to insure the health of the community. Lesson 11 will discuss and reveal the importance of sewage disposal in Phoenix.

Approach:

1. Why is it necessary to remove sewage from the community?
2. Why do many people feel the treatment of sewage is an unpleasant occupation?
3. Why isn't treated liquid sewage used to irrigate edible crops?
4. Approximately 25% of all towns in the United States don't have sewage treatment plants. What happens to their sewage?
5. What happens to the rinse water of your washing machine after the rinse cycle?
6. Besides your toilet, what other places in your home is water sent to the sewage disposal plants in Phoenix?
7. What happens to the water that drains from your sink?
8. What natural phenomenon forces liquid waste to travel to the treatment plant? (Gravity)
9. Why are rats sometimes found in sewers?
10. What kind of wastes could not be removed satisfactorily with our present sewage system?

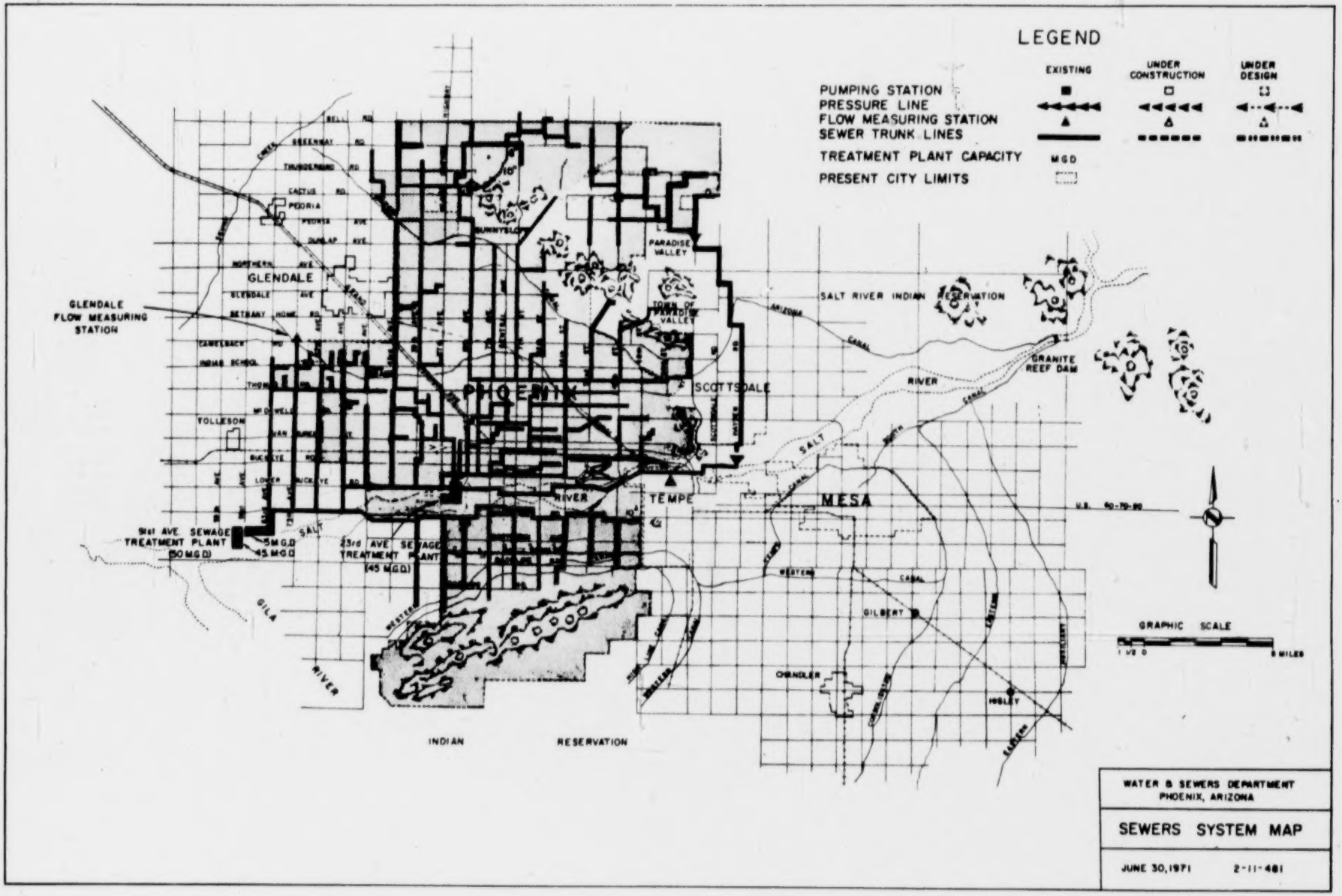
Outline: Sewage Disposal in Phoenix

I. Disposing of sewage in Phoenix
   - A. Sewers system
     1. service area approximately 166 square miles
     2. 2,090 miles of sewer lines
   - B. Sewage treatment plants
     1. 23rd Avenue Plant - 21.6 million gallons daily
     2. 91st Avenue Plant - 52.3 million gallons daily

TEN YEAR REVIEW OF SIGNIFICANT SEWERS SYSTEM STATISTICS*

	Item of Record	Increase 1962-1971	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
SEWERS SYSTEMS	Sewer Service Taps in Service	60%	179,730	169,255	160,523	155,828	151,405	145,350	139,088	135,985	124,740	112,496
	Service Area (Square Miles)	73%	166	161	158	154	154	154	150	150	150	96
	Miles of Sewer Lines	70%	2,090	1,968	1,857	1,803	1,747	1,656	1,582	1,540	1,402	1,228
SEWAGE TREATMENT	Design Capacity - 23rd Ave. Plant (MGD)	0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Average Daily Flow - 23rd Ave. Plant (MGD)	*	21.6	21.8	20.6	12.1	12.0	12.1	21.6	27.9	29.2	29.6
	Maximum Daily Flow - 23rd Ave. Plant (MGD)	*	40.4	27.5	28.4	27.1	15.2	13.5	41.9	43.3	35.4	38.4
	Maximum Flow Rate - 23rd Ave. Plant (MGD)	*	59.0	43.0	48.0	36.5	-	23.5	68.0	65.7	70.0	64.7
	Design Capacity - 91st Ave. Plant (MGD)	1,200%	65.0	65.0	65.0	50.0	50.0	50.0	50.0	5.0	5.0	5.0
	Average Daily Flow - 91st Ave. Plant (MGD)	*	52.3	47.6	40.9	39.8	37.0	27.0	13.3	3.8	4.1	3.8
	Maximum Daily Flow - 91st Ave. Plant (MGD)	*	60.3	55.6	48.5	53.2	55.4	35.6	35.8	6.4	5.0	5.1
	Maximum Flow Rate - 91st Ave. Plant (MGD)	*	88.0	80.3	75.3	74.1	-	55.0	60.0	15.7	7.5	7.5
	Total Annual Flow - Glendale,Mesa,Tempe,Scottsdale (MG)	*	6,059	5,329	4,145	3,904	2,735	**	**	**	**	
	Total Annual Sewage Flow - Both Plants (MG)	127%	26,957.2	25,338	22,447	18,996	17,858	14,287	12,323	11,557	12,160	11,838
	Total Average Daily Flow - Both Plants (MGD)	127%	73.9	69.4	61.5	51.9	48.9	39.1	33.9	31.7	33.3	32.4
	Total Annual Flow - Both Plants (Acre Feet)	127%	82,734	77,750	68,900	58,400	55,100	44,100	38,200	35,700	37,500	36,500

*City of Phoenix, Water and Sewers Department, Phoenix, Arizona


LEGEND
EXISTING
UNDER CONSTRUCTION
UNDER DESIGN
PUMPING STATION
PRESSURE LINE
FLOW MEASURING STATION
SEWER TRUNK LINES
TREATMENT PLANT CAPACITY MGD
PRESENT CITY LIMITS
GLENDALE
GLENDALE FLOW MEASURING STATION
PHOENIX
SCOTTSDALE
PARADISE VALLEY
TOWN OF PARADISE VALLEY
TOLLESON
TEMPE
MESA
GILBERT
CHANDLER
MESA
SALT RIVER INDIAN RESERVATION
GRANITE REEF DAM
SALT RIVER
GILA RIVER
INDIAN RESERVATION
91st AVE SEWAGE TREATMENT PLANT (90 MGD)
5 MGD
45 MGD
23rd AVE SEWAGE TREATMENT PLANT (45 MGD)
GRAPHIC SCALE
WATER & SEWERS DEPARTMENT
PHOENIX, ARIZONA
SEWERS SYSTEM MAP
JUNE 30, 1971
2-11-481

SEWERS SYSTEM

SEWER MAINS, MANHOLES, CLEANOUTS & SERVICE CONNECTIONS IN SERVICE

Fiscal Year ended June 30, 1971
with comparative figures for 1970

SEWER MAINS

Size of Main in Inches	Total Feet In Service 6-30-70	Net Additions this period	Total Feet In Service 6-30-71
4	2,257*	2,290*	4,547*
6	8,472	2,602	11,074
8	8,097,044	523,862	8,620,906
10	451,519	30,527	482,046
12	623,665	8,835	632,500
14	9,111	0	9,111
15	263,233	19,317	282,550
16	7,242	0	7,242
18	191,083	15,881	206,964
21	114,434	11,687	126,121
22	1,325	0	1,325
24	103,062	0	103,062
27	92,753	0	92,753
30	129,966	5,217	135,183
33	61,015	12,486	73,501
36	45,233	11,540	56,773
39	15,728	0	15,728
42	26,832	2,109	28,941
48	13,269	0	13,269
51	6,409	0	6,409
54	14,290	0	14,290
60	5,422	0	5,422
66	7,128	0	7,128
69	33,557	0	33,557
72	23,908	0	23,908
81	20,155	0	20,155
87	10,511	0	10,511
90	12,448	0	12,448
Total Feet	10,391,071	646,353	11,037,424
Total Miles	1,968.01	122.41	2,090.42

MANHOLES, CLEANOUTS & SERVICE CONNECTIONS

	Total in Service 6-30-70	Net Additions this period	Total in Service 6-30-71
Manholes	23,153	2,177	25,330
Cleanouts	3,617	250	3,687
Service Connections	169,255	10,475	179,730

*Pressure Line

C. Sewer Maintenance
   1. cleaning of sewer lines
   2. repair
   3. control of roaches and rats

D. Future Plans
   1. Designs for future allow for orderly growth.
   2. Need will increase for more and better sewage plants

Activity:

1. Discuss ways in which water could be conserved when disposing of waste.

2. Each student can design his or her own municipal sewage disposal plant.

3. Arrange a tour to one of the city's sewage treatment plants.

4. Make a chart that shows the steps of sewage treatment.

Resource Material:

Film, "The Water Is So Clear That A Blind Man Could See" National Educational Television Film Service or Project Outreach. 16mm/30 mins./color

Lesson 12: Argiculture in Arizona

Aim:

Arizona farmers are literally forced to wise use of water. Over 300,000 acres of suitable agricultural land in Arizona cannot be used because of a short supply of water. Water will enable the soil to produce; therefore, we need to utilize our water resources as conservatively as possible. Lesson 12 will show the importance of water for agriculture in Arizona.

Approach:

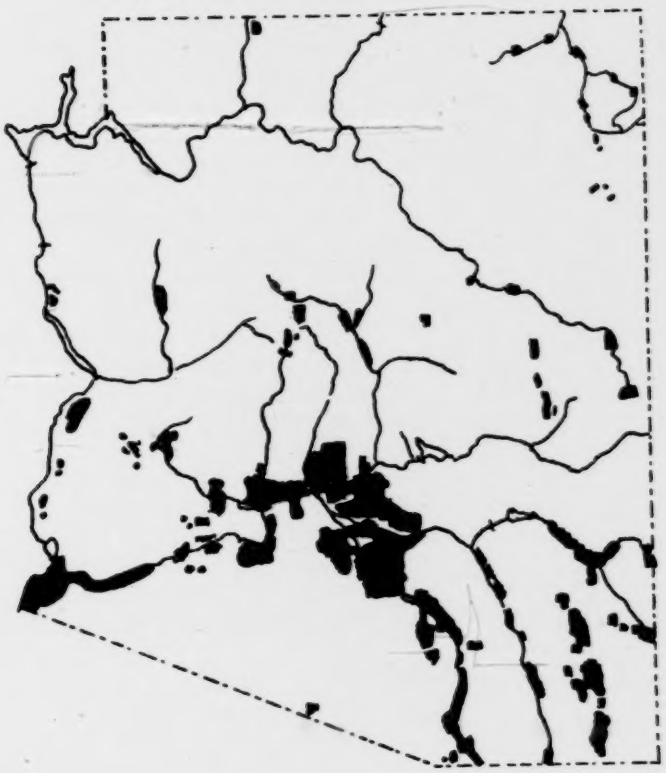
1. If Arizona suffered a serious water crisis, would this affect the price of produce and meat?
2. Why is the lower Salt River mostly dry the year round?
3. What will too much water do to a crop?
4. How would you construct an irrigation ditch to conserve water?
5. Why are farmers careful about how much water they use?
6. How can leveling of a field increase crop yield?
7. Why would you suspect the chemical content of a lake would be different after a rainstorm?
8. Why is water important to soil?
9. Why do farmers remove plants growing on the banks of irrigation ditches?
10. It is thought early farmers in Arizona (600-1000 years ago) did not fail to produce crops because of a water shortage. Explain.

Outline: Arizona Agriculture

1. Agriculture in Arizona
   - A. Early origins
     1. Ho-Ho-Kam people
        - a. 600-1000 years ago
        - b. farmed over 100,000 acres of Central Arizona
   - B. Aspects of agriculture in Arizona
     1. Irrigation
        - a. largest single use of water in Arizona
        - b. efficient management necessary
        - c. short supply of water; need to conserve
     2. Water management
        - a. need for more knowledge about water-soil plant relationships
        - b. in the past, irrigated when it "looked" like plants needed it
        - c. well managed today
     3. Land leveling
        - a. uniform distribution of water
        - b. uniform plant growth
        - c. easy to control water for productive use
     4. Ditch lining
        - a. lining farm ditches with concrete
        - b. saves tremendous amounts of water
        - c. less water needed to irrigate lands
   - C. Source of water
     1. Salt River System
        - a. varies in quality
        - b. controlled by dams
        - c. used for irrigation, municipal, and industrial
     2. Gila River
        - a. boron content detrimental to crops, limits use
        - b. diverted for agriculture
        - c. has caused mottled teeth in children
     3. Colorado River
        - a. major diversions below Parker Dam
        - b. mostly diverted for irrigation
     4. Miscellaneous rivers
        - a. Agua Fria - all diverted for agriculture
        - b. Hassayampa River - diverted for irrigation and mining
        - c. San Carlos - meager data on quality. Often no flow during each year
   - D. Uses of agricultural water
     1. Arizona's principle crops: alfalfa, citrus, cotton, grains, and vegetables
     2. Irrigates 1,160,000 acres throughout the state
     3. 300,000 acres cannot be used due to lack of water
     4. Gross value of Arizona crops exceeds 300 million dollars

ARIZONA AGRICULTURAL STATISTICS

Irrigated Areas in Arizona



DISTRIBUTION OF FARM ACREAGE BY COUNTIES - 1965

County	Alfalfa	Citrus	Cotton	Grains	Vegetables	Total
Apache . . .	2,000	-	-	5,440	40	8,400
Cochise. . .	12,000	-	13,486	53,400	4,900	87,866
Coconino . .	200	-	-	2,400	-	7,200
Gila	300	-	53	150	-	893
Graham . . .	6,100	-	17,850	27,510	140	53,800
Greenlee . .	1,000	-	1,700	2,350	100	5,850
Maricopa . .	95,000	15,940	128,000	161,600	51,000	481,120
Mohave . . .	1,800	-	270	530	100	4,900
Navajo . . .	4,600	-	-	13,000	200	18,900
Pima	1,000	50	23,385	22,700	500	49,715
Pinal . . .	20,500	85	123,100	79,840	4,900	247,000
Santa Cruz .	300	-	1,001	460	20	2,181
Yavapai. . .	3,200	-	10	3,600	100	8,660
Yuma	43,000	22,900	30,145	35,020	39,000	183,515

Note: Acreage double cropped is counted but once, and not all crops are shown.

Source: University of Arizona "Arizona Agriculture, 1965"

EXHIBIT 3

NUMBER OF ACRES DEVOTED TO ARIZONA'S PRINCIPAL CROPS

Year	Alfalfa	Citrus	Cotton	Grains	Vegetables	Total Acres
1960	231,000	29,078	426,095	378,000	99,500	1,263,673
1961	227,000	29,335	392,000	368,000	99,500	1,209,835
1962	210,000	31,025	405,000	301,000	96,650	1,172,675
1963	193,000	33,165	387,000	333,000	101,635	1,165,800
1964	201,000	34,785	375,000	365,000	104,540	1,154,000
1965	191,000	38,975	339,000	408,000	101,000	1,160,000

Note: Acreage double cropped is counted but once, and not all crops are shown.

Source: University of Arizona "Arizona Agriculture".

COMPARATIVE YIELDS PER ACRE - 1965

Crop	Arizona	U.S. Average	Crop	Arizona
Alfalfa seed, lbs.	180.00	202.00	Oats, bu.	42.00
Barley, bu.	73.00	43.50	Potatoes, cwt.	210.00
Cotton, lbs.	1,097.00	531.00	Sorghum, bu.	70.00
Hay, tons	4.77	1.82	Wheat, bu.	46.00

Source: U.S. Department of Agriculture, Arizona Crop & Livestock Reporting Service

GROSS VALUE OF ARIZONA CROPS AND LIVESTOCK

Livestock and Products	1963	1964	1965
Cattle and Calves	$174,800,000	$153,700,000	$190,100,000
Dairy Products	26,400,000	29,500,000	30,600,000
Sheep, Lamb & Wool	5,600,000	4,700,000	8,200,000
Poultry & Eggs	7,400,000	7,700,000	5,700,000
Miscellaneous	2,500,000	2,600,000	3,300,000
TOTAL	$216,700,000	$198,200,000	$237,900,000
Agricultural Crops			
Cotton Lint & Cottonseed	$154,800,000	$134,600,000	$133,100,000
Lettuce	50,000,000	47,300,000	54,800,000
Cantaloupe	17,400,000	15,800,000	14,400,000
Potatoes	5,500,000	7,600,000	9,700,000
Watermelons	1,600,000	1,400,000	1,100,000
Onions	2,800,000	1,100,000	3,900,000
Carrots	2,000,000	1,600,000	2,100,000
Celery	100,000	200,000	200,000
Broccoli	500,000	300,000	300,000
Cabbage	1,100,000	600,000	700,000
Cauliflower	400,000	400,000	500,000
Misc.Vegetables	6,300,000	5,500,000	5,700,000
Feed Grains	25,700,000	28,900,000	33,500,000
Hay	32,800,000	26,000,000	27,400,000
Citrus & Grapes	22,700,000	21,400,000	17,600,000
Seed Crops	5,800,000	6,100,000	5,400,000
Miscellaneous Crops	14,200,000	10,100,000	10,900,000
Forest Products	17,200,000	17,200,000	15,300,000
Federal Government Payments	4,400,000	5,800,000	7,800,000
TOTAL	$365,300,000	$331,900,000	$344,400,000
GRAND TOTAL	$582,000,000	$530,100,000	$582,300,000

Source: University of Arizona "Arizona Agriculture, 1966"

5. Leaching
   a. keeps salts moving below root zone
   b. contributes to ground water supply

E. Water quality problems
   1. Salinity - too many salts in the root zone can damage or kill plants
   2. Sodium relationships - excess sodium salts in the soil may replace other important elements
   3. Boron - citrus trees are very sensitive to boron. Excess boron causes yellowing, premature leaf drop, burning, and a poor yield.

F. Future outlook
   1. increased population creates more demand from the land
   2. Arizona farmers constantly seeking new and practicable methods of irrigating

Activity:

1. Using two stalks of celery, place one in a glass of water and the other in an empty glass. Observe the results. How does this prove water is essential to agriculture?

2. Make arrangements with a local farmer to tour his fields. Examine his methods of water delivery.

Resource Material:

Film, "Environment" Project Outreach — BFA Educational Media or 16mm/28½ mins./color

Lesson 13: Water Recreational Problems

Aim: The maintaining of our water quality standards for our lakes and rivers is becoming a problem in Arizona. The increased usage of our lakes and rivers for recreation is bringing about unsightly and harmful pollution. The quality of the water must be maintained even if it means restricting recreational uses. Our water in Arizona is in short supply and is necessary for our well being. We cannot afford to have it become polluted from recreation. Lesson 13 will show the problems involving recreational use of our lakes and rivers.

Approach:

1. How does pollution harm a lake?
2. What restrictions should be made concerning water recreation?
3. If a poison only killed the plants in a lake, would the animals in the lake eventually die? Explain.
4. If a lake became cluttered with surface debris, what effect would this have upon the aquatic plants? (block-out sunlight)

5. Water that is unfit to drink may be safe to swim in. Why?
6. Why do lakes smell differently than swimming pools?
7. How are lakes and swimming pools similar? Different?
8. How are lakes made?
9. How are lakes and rivers used for recreation?
10. How does an oil or gas spill affect a lake or river?

Outline:

1. Water quality for recreation
   - A. Fishing and hunting
     1. protection of the propagation of living organisms
     2. protection of food chains and habitat
     3. aquatic organisms are sensitive to copper and zinc
   - B. Boating
     1. increased popularity of water craft
     2. pollution from outboards affecting plant and animal life
     3. noise pollution
     4. adequate facilities needed for use
     5. water needs to be free of floating debris and suspended solids
   - C. Swimming (includes diving)
     1. The water should be free of harmful organisms.
     2. Water needs to be free of obnoxious odors and objectionable color.
     3. Water should not have substances which would harm the skin.
     4. Toxic substances should not be in the water in case of swallowing.
   - D. Aesthetic enjoyment
     1. Boating may harm aesthetic enjoyment.
        a. fecal matter and toilet paper of boat origin in the water
        b. Chemical inbalance in water may be created by gas and oil spills.
     2. Water should be free of suspended and floating debris.
     3. Foul odors and objectionable color should not be present.
     4. Water should not contain any harmful substances to life.
     5. Substances that may cause excessive biological growths should not be present.
     6. Water should be free from excessive human use.

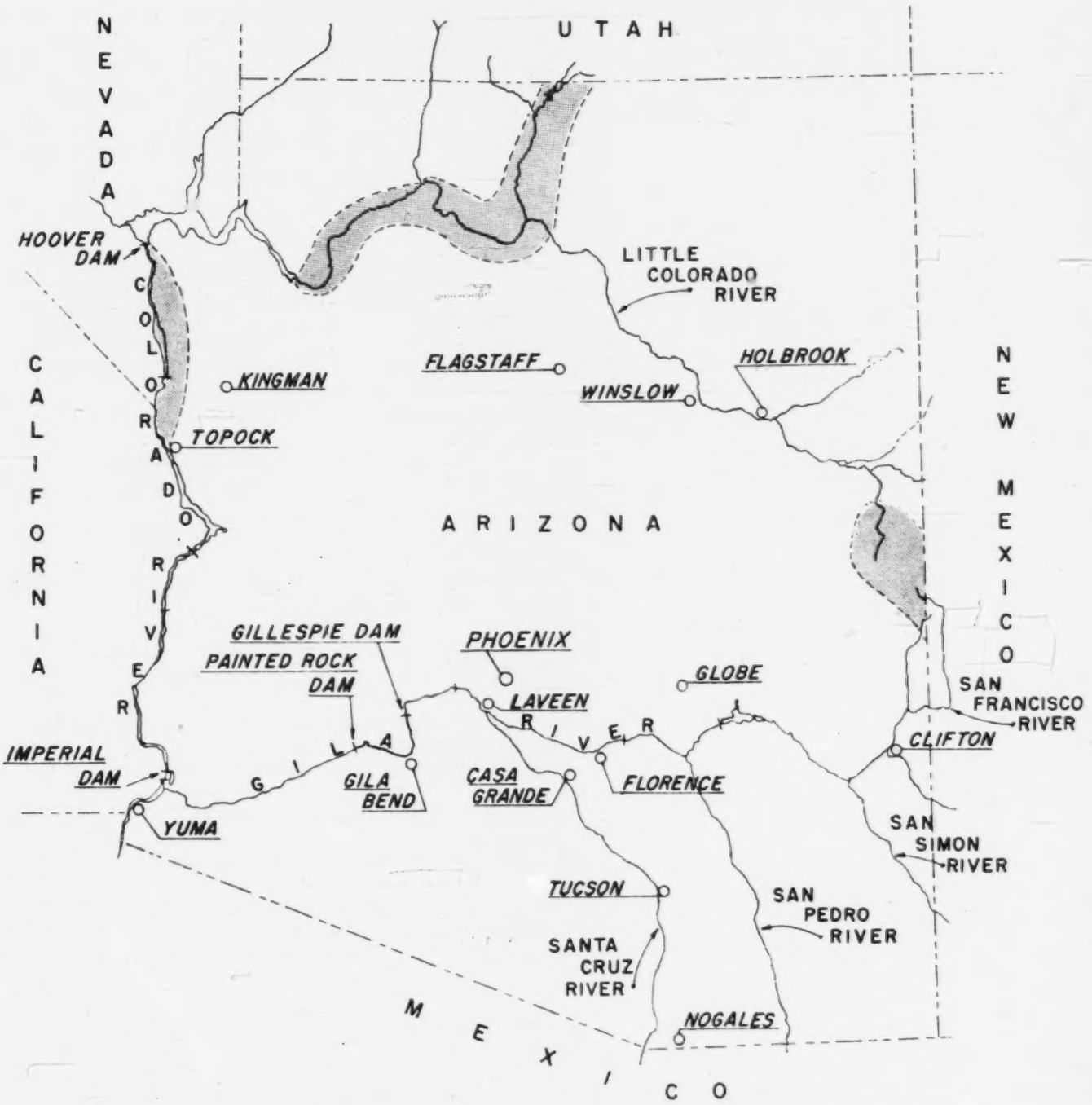
Activity:

1. Ask students to design a park utilizing, but yet conserving, water resources.

2. Debate the issue "Pros and Cons of Water Recreation."

MAJOR COLDWATER AND WARMWATER FISHING AREAS ON INTERSTATE WATERS IN ARIZONA

The major coldwater fishing areas on interstate streams in Arizona occur in the shaded areas; the remaining permanent waters involved provide habitat for various warmwater game and non-game species of fish.



ASDH-DEH-WWS

Resource Material:
Film, "What Are We Doing to Our World", Part I
McGraw-Hill Films or Project Outreach, 16mm/52 mins./color

Lesson 14: Future of Arizona Water

Aim: The future of Arizona water is not promising. The reality is that more industry and more people are coming to our state. The demands for water have increased immensely. Through the use of wise watershed management, cloud seeding, and sound conservation, Arizona will strive to meet the present water demands. Fortunately, state officials are planning ahead for the increased water demand. Lesson 14 will discuss the future of Arizona water.

Approach:
1. If you were unable to obtain any water in your community, how would you get a drink?
2. Do artificial lakes have an effect on the underground water supplies?
3. How would you save water if we had a drought?
4. What ways do you use water that have no bearing on your survival?
5. Why does "mountain water" taste fresher than "desert water"?
6. What would you do for summer recreation if swimming pools were prohibited in Arizona?
7. If you saw a water storage tank leaking, who would you call for help?
8. Does cloud seeding harm the environment in any way?
9. Why does industry use large amounts of water?
10. Can water be made artificially and yet be sold economically? Explain.

Outline: "Arizona Water - It's Future"
1. Future of Arizona water
   - A. Present uses
     1. industrial
     2. municipal
     3. agriculturul
   - B. Present sources
     1. watershed management
     2. annual rain and snowfall
     3. groundwater supplies
   - C. Problems
     1. treatment and costs
     2. supply verses demand
     3. storage and costs
     4. high cost and pumping
     5. droughts
   - D. Future needs and programs
     1. domestic use increasing
     2. increased industrial use
     3. more leisure time, more recreational use

4. Proposed Central Arizona Project will bring more water to Central Arizona.
5. cloud seeding to increase supply
6. piping water from desaltation plants along coastal waters proposed.

Activity:

1. Ask students to devise a method in which water can be obtained if natural sources are unable to supply our needs.

2. Design a bumper sticker with the theme "Conserve Arizona's Water".

3. Ask students to make posters with a theme concerning Arizona water.

Resource Material:

Film, "What Are We Doing to Our World", Part II
McGraw-Hill Films or Project Outreach, 16mm/52 mins./color

AIR POLLUTION

Lesson 1: Analysis of Clean Air

Aim:

To develop basic concepts regarding air through discussion and personal observation.

Approach:

An analysis of clean air, such as air collected over the ocean, shows it to consist of a mixture of gases, chiefly nitrogen, oxygen, carbon dioxide, and traces of a few others.

A. Is the above sufficient information to describe air everywhere?
   1. at the seashore - damp, cool, salty - why?
   2. in the desert - dry, hot - why?
   3. on a mountain top - thin - why?
   4. in the forest - cool, fragrant - why?
   5. in the fields - hot, cool, damp, dry, fragrant - why?
   6. near a barnyard - malodorous, offensive - why?
   7. in the city - all of the above - why?
   8. the bottom of a mine
   9. in the kitchen

B. Of what use is air?
   1. hold your breath - for how long can you do this?
   2. burn candle in jar
   3. aquarium experience
   4. grow plants in a vaccuum
   5. air conditioning in a room - why?

C. Can we detect air with our senses?
   Touch, taste, smell, hear, feel, see - describe each. Under what circumstances, or what makes it possible?

D. What is a breeze, wind, tornado, cyclone?
   Discuss, use dictionary, encyclopedias.

E. Is air always good? bad?

Activity:

Use glossary and dictionary for special terms.
Spelling, meaning, use of terms
Experiment with anemometer and fan.

Lesson 2: What Is Pollution?

Aim:

To develop concepts regarding pollution, contamination - their meaning and extent.

Approach:

Air, according to the chemist consists of a few gases but air as we know it can make us feel comfortable or uncomfortable.

A. If air is not always good, not always bad, what makes the difference?
   Pollutants, contaminates, etc.

B. How do they get into the air?
   1. Naturally
      volcanic emissions
      ocean salt
      dust
      pollen
      products of photosynthesis (blue haze)
      nitric acids, nitrates (lightning)
      oxidants (sun action)
   2. Activities of man
      dust
      gases - carbon monoxide, sulphur dioxide, hydrocarbons, sulphides
      soot, cinders, fly ash
      iron oxide (foundries)
      flourides (mining of phosphates)

C. What are some characteristic effects of these substances? Elicit some responses and discuss others.

D. How do we know pollutants are present?
   1. the senses
   2. the effects (coughing, choking, eyes tearing, specks in the eyes), plants dying
   3. monitoring - high volume, smoke and haze, effect on sunlight, special instruments for gases

Activity:

Collect particulants through a filter (refer to Unit on aesthetics.)
Visit air pollution station

Lesson 3: Sources of Pollution

Aim:

To delineate some specific sources of pollution and some factors which modify their effects.

Approach:

Man's activities contribute to pollution in the atmosphere

A. Elicit and list (in class) some of the activities of man which contribute to air pollution and some of the pollutants so contributed.
   1. Define aerosol, particulate, gas
   2. Automobile - carbon monoxide, hydrocarbons, particulates, rubber, metals (abrasive actions)

3. Using unpaved roads - dust
4. Burning trash - gases particulates
5. Grinding operations - various dusts of varying hazardous nature
6. Smelting - gases (SO_2), particulates, metal oxides
7. Mining - dusts
8. Dry cleaning - volatile solvents
9. Smoking - particulates, hydrocarbons, carbon monoxide
10. Painting - volatile solvents, lead
11. Hairsprays - solvents, plastics
12. Others - waste disposal, power production, transportation

B. Elicit and/or discuss factors which have a bearing on the amount of pollutants which may burden the air in any locale.
   1. How much pollutant is being emitted; from how many sources; of what varieties; how close together; how many people, plants, animals are in or bathed by this air?
   2. Meteorology
      a. effect of rain, humidity
      b. effect of sun
      c. effect of winds - velocity
      d. meaning and effect of atmospheric inversion

Activity:

Collect news items, pictures of air pollution
Reports on legislation
Resource person to tell class about control, etc.

* Lesson 4: Pollution Control

Aim:

To impart principles and practices of air pollution control.

Approach:

Nature has made available, and has used chemical, physical, and biological means for purifying the air. Many of these means are available to man, and man has, in a few instances, improved on nature's techniques.

A. Can you describe some of these means? How can each be used by man? What other techniques are available?
   1. Rain washes particulates and gaseous matter out of the air. Water curtains and sprays are installed along the path a pollutant takes and gases and particulates are washed out.
   2. Sandy earth filters water and removes entrained matter. Miscellaneous filters

such as sacks, bags, glasswool placed in the path of a polluting air stream similarly remove particulates.

3. Winds blow pollutants away.
   Extra air is blown through emission stacks and vents to dilute the pollutants down to acceptable levels.
4. Change the process so as not to pollute.
   Copper smelters roast ores in hot fires. Sulphur in the ore is burned to sulphur dioxide, a serious pollutant. This can be prevented by dissolving the copper or using chemical means.
5. Replace the offending pollutant with a non-offending substance.
   Use of non-volatile substances to replace volatile substances in dry-cleaning operations.
6. Improve techniques so that a better job is done. When burning fuel for heat or power, or gasoline in an automobile, use equipment or change the process so that better burning is accomplished; e.g. refuse incinerators - 3 chambers for burning.
   Automobile - higher temperatures and better mixtures of fuel and air will result in more complete combustion of fuel.
7. New use for an existing known phenomenon.
   If a plastic rod is rubbed by a piece of fur, it will become electrostatically charged and attracts and collects many particles. This can and is being duplicated using electric currents which charge surfaces sufficiently to attract and capture large quantities and particles in smokestacks.
8. Change the harmful material to a harmless one. Acids can be neutralized running smoke through baths of alkali and vice-versa.
9. Devise a process which makes it possible to pay for the cost of control where this was not formerly possible. Use the heat from an incinerator to make power, or to purify water.
10. Escape the trapping effect of atmospheric inversion by building smokestacks high enough to penetrate into the upper air.
11. Odors - use odorous air (rendering plan) as combustion air for burning standard fuel. The odorous component burns away in the process.

Summarize:

Control can be attained by wash out, burn out, filter out, change of process, use of counteracting materials, substitution of harmless materials for harmful ones.

Activity:

Experiment described in #7 above.
Run smoke through a filter.

Lesson 5: Air Monitoring

Aim:

To give some insight into accurate air monitoring technology.

Approach:

Air pollution may be local or widespread. It may consist of particulates, gases, or combinations of both. It may be found in heavy or light concentrations wherever it is found.

A. Can one trust our senses to give accurate records and values?
   1. odors
   2. visibility
   3. personal reactions

B. What does a vaccuum cleaner do? How can we use this technique to measure particulate pollutants?
   1. weigh the filter before and after
      know how much air went through the filter
      know the porosity (what size particles pass through)
   2. What did we capture? - how much? - what didn't pass through

C. Is there a good way to determine interference with visibility?
   1. Ringelmann scale
   2. Use of standardized places such as peaks, buildings, etc., to measure visibility by numbers of miles

D. Can we do the same for gases and other substances?
   Special chemical traps for acids, bases, sulphur dioxide, flourides, lead, ammonia, oxidants, carbon monoxide. These are based on automated chemical reactions and recording automatically on charts.

Summarize:

Special equipment is available to capture pollutants from the air, both particulate and gas, and to identify the pollutant by nature, quality and quantity.

Activity:

Visit air pollution monitoring laboratory.
Make charts of daily wind speeds and note visible differences in air pollution.

TEACHING AIDS

Films

America and the Americans, McGraw-Hill
House of Man, Part 1; Encyclopedia Britannica
Problems of Conservation - Air, Encyclopedia Britannica
The World Around Us, McGraw-Hill

Filmstrips and Loops

Ecological Crisis, Singer SVE
Environmental Crisis, Student National Education Association
Environmental Pollution , Wards National Science Est. Inc.
Pollution, Abt Association, Inc.
Young Scientists Investigate Pollution, Singer SVE
What's in the Air, Urban Ecology Series
Production of Oxygen by Green Plants
America's Urban Crisis, Singer SVE

Study Kits

Why Are Leaves Green, Urban Systems, Inc.
Button Bag, Environmental Science Center, Golden Valley, Minn.

Environmental Education Resource Catalog, Project Outreach
Phoenix Union High School System.

Above materials may be obtained from Project Outreach Environmental Education Resource Center.

SOLID WASTE

Lesson 1: Wastes as a community and personal problem.

Aim:

To identify the problem.

Approach:

Human activities result in the generation of large quantities of many varieties of wastes, presenting problems in their storage, handling and disposal.

A. What does the term wastes, as they concern man, mean?

Dictionary Definition: damaged, defective, superfluous, rejected materials; scrap, garbage, rubbish, excrement; fluids allowed to escape without being utilized; sewage, refuse from places of human and animal habitation.

B. Elicit specific examples of common wastes: Garbage, rubbish, refuse, paper, glass, rubber, plastic, tin cans, barnyard manure, construction and demolition debris, timber, rocks, concrete, metal, auto bodies, tires, trees and brush, paint, solvents, sewage, industrial wastes.

C. Why worry about wastes at all?

1. They take up useful space and destroy land values.
2. They are unaesthetic, unsightly.
3. They can cause accidents (cuts, bruises) and support costly fires.
4. They may be unhealthful, Garbage supports fly and rat populations, bearers of disease.
5. They generate foul and offensive odors, sometimes poisonous gases.

D. Who is responsible for providing the solution to these problems?

1. Individuals who produce the wastes and to whom they belong.
2. The community in which he lives.
3. The agencies to whom he has given the responsibility for carrying out the waste disposal function.

Activity:

A walk through the neighborhood to observe the area - garbage cans, plastic containers, boxes used for disposal, etc., then write about what they saw, may also take pictures.

Lesson 2: Wastes as a community and personal problem.

Aim:

To expand Lesson 1.

Approach:

Although we have identified wastes by name, in order to go about the business of solving our waste problem, we need to know more about its nature and origin.

A. Can we classify wastes in another useful way?
by origin?
1. Industrial - chemicals, scrap metals, solvents, cartons, etc.
2. Commercial - paper, wrappings, cartons, cases, crates, boxes.
3. Agricultural - cuttings, trimmings, culls, trees, manure.
4. Domestic and Municipal - source of the above and all the rest as in Lesson 1.

As individuals we are most concerned with domestic and municipal wastes.

A. How many domestic wastes can be classified?
Paper - 59%; wood, lawn and garden waste - 10%; glass, ceramics, ash - 8½%; metal - 7½%; clothes, rags, plastic, rubber, leather, dirt - 6%.

B. How much material are we talking about?
1. The average individual produces about 1800 lbs. per year of combined wastes.
2. How much is this in tons for your city? (Phoenix - population 640,000)
3. If one ton takes up _____ cubic yards, how many cubic yards is that for Phoenix? How many classrooms full?

Activity:

Visit a landfill.

Lesson 3: What To Do With Solid Wastes.

Aim:

To impact some perspective regarding the collection, storage and disposal of these wastes.

Approach:

Now that we have gained some knowledge regarding the identity and nature of wastes, it would be useful to determine the best ways to handle them.

A. What do you do with solid wastes now?

1. Set it out for pick-up.
   Advantages and disadvantages:
   The best - but you may not have pick-up service
   - containers are needed
   - must be set out in the right place for pick-up.
2. Dump it on the desert, in the alley, on a vacant lot. Illegal, draws flies, rodents, destroys land, fouls up your neighborhood.
3. Burn it - illegal unless you have an approved incinerator.
   - creates air pollution
   - leaves residues which still must be disposed of
4. Bury it - how about large, bulky objects? Where? for how long can you do this? illegal in some places.
5. Down the garbage grinder
   - illegal in some places because of inadequate sewage and disposal systems.
   - doesn't handle everything, in fact only a small part.
6. Feed it to animals - what are the advantages and disadvantages? Elicit responses.
7. Take it to the city landfill.

Activity:

Draw pictures to show advantages and disadvantages of various means of disposal.

Lesson 4: Solid Waste Disposal Systems

Aim:

To expose the class to the techniques which are accepted or being experimented upon in the disposal of wastes.

Approach:

Certain methods are now being employed to dispose of our solid wastes. Some aspects of these methods are experimental, but all are being used somewhere in our nation and the world. What are they and what are their characteristics?

A. The sanitary landfill - a sanitary landfill is a piece of land to which wastes are taken, deposited and covered in a healthful, nuisance - free manner.
   1. Location
      a. Enough land to last for years (10 or more if possible)
      b. Located so as not to annoy neighbors.
      c. Located near enough to the sources of wastes so that cost of hauling is not excessive.

d. Preferable that it be excavated or depressed at outset. A depression makes a good start, but this can be attained by other means.

e. The soil must be workable so that plenty of clean soil cover is available.

f. Not located where the operation will result in water pollution.

g. An ample supply of water is necessary to hold down dust and to extinguish accidental fires.

2. Equipment

a. Heavy earth moving equipment for excavation, moving soil, covering finished areas, compressing the wastes into least feasible volume.

b. Trucks, water supply system, communications, shelter, fences, directional and instructional signs, fire fighting equipment.

3. Personnel

Manager, equipment operators.

4. Good all-weather access roads.

5. Operation

a. Refuse is brought to landfill site and dumped in the most confined or limited areas.

b. Heavy equipment moves the refuse into place and by running over it repeatedly, crushes, and reduces its volume.

c. At the end of each day 6 inches of clean soil is placed over the working surface of the refuse.

d. When the cavity has been filled it is covered with an additional soil cover of at least 30 inches leaving the site finally in a level or finished condition.

6. Follow-up

Periodically the landfill is inspected and breaks, openings in the cover, or where the finished surface may have collapsed, are repaired.

7. Ultimate use

Parks, playgrounds, golf courses, building construction for light weight buildings, some agriculture (e.g., cotton is raised on finished landfills.)

Activity:

Visit to landfill, take pictures. Draw pictures showing what can be done with finished landfill.

Lesson 5: Solid Waste Disposal Systems.

Aim:

Continuation of Lesson 4.

Approach:

An incinerator is a piece of mechanical equipment into which solid wastes are placed and ignited so that all combustible parts of the wastes are burned up.

B. Incineration

1. Location

Since incinerators are like industrial operations and may emit smoke, flame, particulates, gases, odors, in addition to storing waste awaiting processing, they should be located where they will not offend the public.

2. Equipment

Waste storage bins

Incinerator - usually a multi-chambered furnace in which material may be dried somewhat, ignited, burned in increasingly hot fires.

Ash Storage

Smoke-stack

Trucks for ash removal

Refuse moving equipment, sometimes automatic conveyor belts

Communications, shelter

Water supply for cooling, fire fighting

3. Personnel

Managers and operators

4. Operation

Miscellaneous refuse is dumped on a receiving platform from which it is pushed or conveyed into the first chamber. Here it is ignited and burning begins. The burning material is moved progressively to hotter and hotter parts of the furnace until all combustibles are consumed. The residue may be permitted to cool or is quinched with water, loaded on vehicles and removed.

Advantages:

The volume of material which must be finally disposed of is much reduced, sometimes to 1/5 the original.

The heat which is generated can be used to make power for many uses.

Certain parts of the ash can be re-used. Saves land.

Disadvantages:

Useless for handling materials which will not burn. Often a source of serious air pollution.

The residue (ash,etc.) must be disposed of somewhere. Thus, additional equipment, handling, land and personnel are needed.

Should the incinerator break down an alternate disposal site such as landfill is needed.

Vehicles hauling burned out ash, etc., from the incinerator frequently create a nuisance themselves as they pass through the community.

Lesson 6: Solid Waste Disposal System.

Aim:

Continuation of Lessons 4 and 5.

Approach:

Recycling and composting in their broadest sense, involves the application of a number of techniques to waste disposal with the aim of recovering physical resources which have been discarded in the wastes. There are a variety of techniques used.

C. Composting or recycling

1. Equipment

Receiving stations
Sorting stations
Crushers, grinders, magnets, separators, storage areas for raw material and finished products.
Refuse moving trucks, bulldozers, conveyors
Water system for dust and fire control
Shelter, communications
Power

2. Personnel

Manager, operating personnel.

3. Operation

Municipal wastes are deposited in the receiving area where it is converted into a steady stream of limited dimension. The stream moves through a sorting area where glass, paper, rags, plastics, various metals are selectively removed from the stream and sent to selective storage. The residue from this phase of the process is ground up and moved to special chambers where it remains for a specific time under controlled temperature and moist conditions. Here bacterial and fungal action reduces the material to a stable, pasteurized condition.

Further grinding and storage completes the stabilization and the material may be used as a soil conditioner, pressed into briquets or subjected to other processing into useful material.

Advantages:

1. A substantial fraction of what we call wastes are returned to highly diversified availability and use.

2. Wastes become resources.

3. Resource recovery can pay for past or all of the waste disposal.

Disadvantages:

Costly

Can create environmental nuisance - fires, dust, noise, unaesthetic.

There must be a ready nearby market for the recovered resources to help make the process pay.

Not all materials in wastes lend themselves to composting (plastics, bricks, rugs) and they must be disposed of somewhere else.

If the plant should break down, an alternative method of disposal must be available, since solid wastes production by man is continuous.

Lesson 7: Recycling

Aim:

(Continuation)

Approach:

It has been said many times that because the American people are endowed with huge material resources, they tend to be careless of their consumptions and disposal. In recent years we have become more and more aware of this and are attempting to reverse this attitude.

To expand the concept of resource recovery from solid wastes.

D. Recycling

1. It is now popular to speak of re-cycling of resources. What is commonly meant?

The extraction of materials from solid wastes and their conversion from waste to usefulness.

What can be recycled?

glass - returned to mills to make new glass
- ground-up and used in road surfacing
- bottles cleaned and re-used as bottles
- 35% of incinerated ash is glass

paper - returned to paper mills and converted to fresh paper.
- 20% is re-cycled now

iron and steel - 20% is re-cycled in steel foundaries and used as a basis in the manufacture of new metal ingots, shapes and forms.

copper and aluminum, etc. - returned to smelters, purified and re-used.
- 20% of aluminum comes from scrap.

food waste, lawn and garden refuse - composted into soil conditioners and enrichers.

rags - used in paper manufacture and as a source of fiber.

rubber - can be burned for power, used to resole shoes (auto tires)

timber and logs - recut to useful sizes, converted into charcoal, burned directly for power.

bulk wastes - deposited on ocean floor making ideal harborages for the congregation of fish, spawning areas.

brick - used brick is as valuable as new brick in certain kinds of construction - particularly residential.

Activity:

Collections of various items and taken to re-cycling centers.

SOLID WASTES

Films

House of Man - Part 2, Encyclopedia Britannica
They Care for the Nation - Mission Possible, McGraw-Hill
Our Land Needs Your Help, Arthur Barr
Life In A Vacant Lot, Encyclopedia Britannica
Garbage Explosion, Encyclopedia Britannica
Cities of the Future, McGraw-Hill
Conservation, A Job for Young America, McGraw-Hill
Conservation for the First Time, McGraw-Hill
Environment, BFA Educational Media

Filmstrips & Loops

Leaf Litter, Ealing Corporation
Garbage Dumps, Ealing Corporation
America's Urban Crisis, Singer SVE

Study Kits

Earth Corps - Environmental Study Kit
Life from Death - Environmental Game, Urban Systems, Inc.

Above materials may be ovtained from Project Outreach Environmental Education Resource Center.

AESTHETICS OF VISUAL POLLUTION

Lesson 1: Developing A Self Concept

Program A: "I'm me, nobody else, but me!"

Interaction:

Turn-off the lights in the classroom. Try to make the room as dark as possible. If this cannot be achieved, you may have to ask your students to close their eyes or wear blindfolds.

Let's imagine the sun has ceased to shine. How will we see? What will we see?

- Electrical Power? Hydro-electric dams may stop because the water has frozen.
- Flashlights? How will we make one without electrical power for machines?
- Candles? How would we know where to look for them?

How will we obtain food?

- Grocery Stores? Hamburger comes from cows which eat grass which grows by sunlight.
- Hunting? How would you see your prey?

How will we keep warm?

- Blankets? No wool.
- Heat? No power.

How will we survive?

- Good question.

Resources:

Film, "Environment", BFA Educational Media or Project Outreach 16mm/28½ mins./color

Program B: "I live in a house because-----because I live there."

Interaction:

Each student has a pencil and paper ready to draw a map. Their instructions are to draw a "secret" map of where they are going directly after school. Most students will draw a map showing their way home. Why would they go home? What is at home that isn't anywhere else?

Program C: "Your own safety is at stake when your neighbor's house is in flames." Horace (65-8 B.C.)

Interaction:

A subtle method to show the dependency students have with their neighbors is to discuss the following example:

Imagine your telephone caught fire and began to melt. The intense heat caused a fire which spread to your curtains. Where would you go for help?

Program D: "There are obviously two educations. One should teach us how to make a living and the other how to live." (James Adams)

Interaction:

"My gosh, the school burned down."

The students have been evacuated from their classrooms because a fire has broken out in a storeroom. Because of another fire, the fire truck could not arrive in time to put out the blaze at the school. The school and library have been destroyed. (What was in the school that was destroyed?)

Because schools are very expensive, another one cannot be built for five years. The students can't go to another school because the nearest one is over one hundred miles away. (How old will you be in five years?)

The parents in the community have gathered in the park to decide how the students will obtain their education. (Will you be able to drive a car in five years? If you were a parent, what would you suggest about the education of the students? Where will you obtain new books, musical instruments, desks, recreational equipment, and tons of paper? Where will you store it?)

If the fire occurred five years ago today, where would you be now?

Program E: "The union of men in large masses is indispensible to the development and rapid growth of their higher faculties." Theodore Parker

Interaction:

"What if ----?" (Discuss the importance of the city to the individual.)

Students are to write down their responses to each "what if?"

1. The dog pound didn't want to pick-up a dog that bit you?
2. The mayor's office was in Buckeye, the city treasurer's office in Sunnyslope, and the city Water Department's Office was in Black Canyon City?
3. The police said they were too buy to answer your call about a prowler?
4. The International Airport was located at Carefree?
5. The city didn't have jails?
6. The city didn't have parks?

8. The city sanitation department didn't exist?
9. The coliseum was built at Lake Pleasant?
10. The firemen charged you for a fire, and you didn't have any money?

Program F: "I am a great friend to public amusements, for they keep people from vice." Samual Johnson

Interaction:

Your students have been given the task to develop a park. The problem is getting people to support their efforts. Most people don't want to help because they fail to see any advantage of having a park in the city. Ask your students how they will convince people a park is necessary.

Lesson 2: Awareness and Perception

Program A: "How aware am I of my surroundings?"

Interaction:

1. Prepare your students for an exercise in perception. They are to close their eyes and identify ten different sounds you will make. Begin by walking across the room (most will not catch this one.) Drop a paper clip into a bottle. Drop a pin on the floor. Open a box; crumble a cracker. The list is endless. At the conclusion of the tenth sound, ask the students to open their eyes and try to guess all ten sounds.

2. Instruct your students they are going to perceive objects in their room they have never "seen" before. This activity is fun. Students find that they have never noticed these objects before. Some will note a crack in the wall, a "spit-wad" on the ceiling, a new poster, a crack in the window, etc. Write down at least ten responses.

Resources:

Film, "A Sense of Wonder"; McGraw-Hill Films, 16mm/51 mins./color

Program B: "I've never thought I lived here until now."

Interaction:

Each student is to make a floor plan of his or her house. Include specifically where the household appliances, beds, televisions, bookcases, tables, house plants, etc., are. Next, include a front and back yard. Draw where the plants are; include the driveway, water meter, fuse box, and water faucets. Observe the problems students have remembering where things are at their homes.

Program C: "My street smells differently than yours, and we have less air pollution than you."

Interaction:

1. Using the Project Outreach Resource Kit, "Kids, Cameras, and Communities", take pictures of what is pleasing to look at in the neighborhood. Include also, what is unpleasant to look at. Take some pictures of an alley, too. Develop the prints and discuss the pictures.

2. Students are asked to describe a street. Take a walk to a nearby street and carefully look at it, smell it, and touch it. Make a listening device by rolling a piece of paper into a cone, open at both ends. Put the large, open end to the street. Listen through the other end.

3. What is the sky like to the north, south, east, and west of your school? Assign students to four groups, one for each direction. Each group is to gather information about its observations. Use drawings and photographs to enhance the discussion.

Program D: "I don't know where Room 54 is!"

Interaction:

1. You'll have to prepare ahead of time for this activity. With the aid of the grounds keeper, determine the kinds of plants are growing on your campus. Determine their origins from a local nursery. Next, look carefully at the plants for the micro-habitats of animals. Look under eaves for a bird's nest, spider's web, etc. Draw a map of the entire school including the playground fields. When you have gathered enough information about the school environment take a walk on the campus. Each child is to have a map and will mark any favorite spots he or she may encounter.

2. Using a camera, take some pictures of areas that are unfamiliar to you and your students at your school. Have a contest to see who can identify specifically where the pictures were taken.

3. With measuring tape, determine the amount of exposed land to that which is covered by buildings, asphalt, or concrete. Should more structures be added?

Program E: "I know I live in a city because my telephone book says so."

Interaction:

Have students discuss how they know they are living in a city

Program F: "We go to the park to listen to the ducks talk at sunset."

Interaction:

1. Take your students outside and examine some plant and animal life. See how many varieties of plants they can find. Look between grass blades for tiny insects. Carefully listen for sounds of the city that you were unaware of before. Listen for cars, voices, trains, airplanes, washing machines, motorcycles, lawnmowers, bells, etc. You hear them now, but why didn't you hear them before?

2. Plan a field trip to Encanto Park.

Lesson 3: Value Judgements.

Program A: "The American system of ruggest individualism" (Herbert Hoover)

Interaction:

1. Do students feel pollution is bad? Most, if not all, will raise their hands denoting it is. Then ask how many have done anything to stop pollution. It's ironic, but many students haven't done anything to prevent pollution because they don't know what to do. Discuss with your students how they can do their part everyday to fight pollution.

2. Take a walk around your school grounds and gather as much litter as you can see. At first this may not seem too exciting to your kids. Tell your students the entire class is going to count and separate the litter. What is the most "popular" kind of litter? Gum wrappers? What area of school was the most litter found on? Are there "hot spots" where litter is constantly being found? Would an extra trash can solve the problem?

3. Prepare a bulletin board using statements from your students about involving themselves with environmental problems.

4. Make a bumper sticker which directs its theme to the individual person to take an active interest in the environment (e.g., "I looked for blue sky today"). Glue the finished signs to non-adhesive side of contact paper. Use the completed product as you would a regular bumper sticker; peel back the waxed paper from the contact paper and adhere the sign to a surface.

Resources:

Film, "Conservation for the First Time", McGraw-Hill
16mm/9 mins./color

Program B: "Only the home can found a state." (Joseph Cook)

Interaction:

1. Discuss with your students the functions of a home. How can a home be more pleasing to look at and yet be practical to maintain? Should a home harmonize with its environment or contrast with it? Should we have more condominium living or more homes? What advantages do condominiums have over private homes? What disadvantages? Is a yard important?

2. How should a home be made to harmonize with its environment? Ask the students to draw their home and add any improvements. Does the presence of an air conditioner improve the appearance of a home? (Obtain brochures from home developers)

Program C: "It is discouraging to try to be a good neighbor in a bad neighborhood." (William Castle)

Interaction:

1. Determine what is the "ideal community" and design it. Using a bulletin board, cut out paper rectangles, black strips of paper, and other materials (Cotton, cellophane, toothpicks), and construct the ideal community of poor design and function. Include models of street lights, fire hydrants, telephone poles, etc.

2. It was suggested that fire hydrants be painted green to harmonize with the environment. Discuss this with your students. Discuss with them why fire hydrants are painted yellow or red; why stop signs are red; why yield signs are yellow. Imagine a stop sign that was black.

Program D: "The first thing education teaches you is to walk alone." (Alfred "Trader" Horn)

Interaction:

1. Discuss reasons for a pleasing school environment.

2. What part does noise pollution play in the learning abilities of children? Do low flying aircraft distract students and disrupt the momentum of their concentration? Do bells or buzzers ring or buzz too long? What effect does the intercom have upon students?

Manufacturers of stereos recommend speakers never be placed above the listener because of adverse psychological effects. Show an environmental film from Project Outreach without the sound.

3. Ask for student opinion about growing plants in the classroom. Would it matter if there were artificial or real plants in the classroom? Determine what advantage or disadvantage artificial or real plants would have on learning.

Program E: "The path of civilization is paved with tin cans." (Elbert Hubbard)

Interaction:

1. What is pleasing to look at? The teacher may show to the students different colors of paper. Determine what colors are the most popular and pleasing to look at. Be sure to stress to the students to be honest in their responses and not to rely on the taste or opinions of others. After you have determined the ten most popular colors, ask the students what colors are most prevalent in a city.

   Do colors have anything to do with how people think or feel? Are the colors the students chose common to the natural world? (Blue sky, green grass, and brown soil.)

2. Using the color activity, go further into a discussion of colors of factories, warehouses, jails, restaurants, theatres, etc.

3. Cities tend to lack a quality of humanism. What effect will this have upon future generations? Will man lose sight of the fact he needs to treat his fellow man as he would himself? How does the aesthetics of a city influence the behavior of man in regards to crime, prejudice, and brotherhood.

Program F: "Choose such pleasures as recreate much and cost little." (Thomas Fuller)

Interaction:

1. The weather report states the smog content in the air is extremely high and dangerous. Your room is equipped with an automatic filtration device which enables clean air to enter the classroom. What type of recreation will you have? Devise Smog Day Games for recreation. Are the games fun? Will your students become easily bored with them? Why do indoor games quickly become boring?

2. Ask your students to design a model outdoor suit to wear during days of extreme smog. The suit must be made to

resist corrosive pollutants in the air and have a self-contained life support system.

3. Recent evidence has shown smog can be harmful to plants. What effect will this have upon the parks of the city? Ask students to design a park, as large as they want, that will not be affected by smog. Perhaps the park could be enclosed in a large dome.

Lesson 4: Action and Reaction

Program A: "Who owns the air I breathe?"

The individual will decide what is aesthetically pleasing in the environment. We talk about stopping pollution, but that would mean stopping the factories that produce our goods. We will always have waste products from production. We need to convert today's pollution to some other usable form. Perhaps slag from mining operations could be used for home construction. Possible? Who knows?

As individuals we need to:
1. identify what is pollution
2. determine what is aesthetically necessary to man
3. determine who is polluting
4. know the basic needs of the individual
5. be willing to sacrifice many material things
6. reconsider our values
7. be rational with our environmental demands
8. be patient, but firm

Interaction:
1. Write down a list of the ways you inadvertently contribute to the degradation of the environment, e.g.
   1. using too many materials made by large polluting factories
   2. leaving the television set on when you're not watching it
   3. using too many aerosal sprays
   4. using too many electric lights at home
   5. using paper towels instead of rags

2. Ask your students to make their own environmental quality button.

3. Make your own environmental vocabulary. Have your own homeroom word for smog, pollution, ecology, etc.

4. Without becoming an ecoextremist discuss the problems confronting environment. Have your students bring in "Eco-pornography" (advertisements from automobile manufacturers selling larger and more powerful engines.) Power company advertisements, etc.

Program B: "You put bricks in the toilet?"

Interaction:

1. Discuss with your students about growing their own garden. Flower seeds may be too expensive, suggest buying boxed hamster food or bird seed sold in Pet Shops. Pet foods are relatively inexpensive, and the seeds germinate in about a week.

2. Practicing eco-sense is important in a world rapidly consuming its resources. Discuss with your students, water conservation in the home (e.g., putting a brick in the toilet tanks. To obtain warmer water, decrease the cold, not increase the hot.) Incorporating eco-sense in the home may ramify to the community as a whole.

Program C: "We can see the smog in downtown Phoenix from here. Sure glad we don't have any."

Interaction:

1. Each student is given two sheets of white paper. Cut out most of one sheet leaving a two-inch wide border. Place the cut-out border evenly on top of the whole sheet. Paper clip or staple the two sheets together. Do not glue them together. Leave the sheets out overnight on top of your roof or car, frame side up. Next morning, carefully remove the frame portion. Examine the bottom sheet under a light. Particulate matter may have fallen during the night on the exposed part of your first sheet. Framing the particulate matter will be the part of the paper you covered.

   Where does this particulate matter come from? Have you seen, tasted, or smelled it? Spray your results with a fixative and mail them to public officials, industrialists and the newspaper.

2. Discuss why a neighborhood clean-up campaign <u>will not work</u>. Using this "reverse psychology", chances are you'll have your first clean-up before you know it. Be sure and obtain a street map of the area and assign duties to groups of students. Recycle aluminum cans for profit.

3. Request information from the Health Department about the particular matter falling in your neighborhood.

4. Group your students to write letters to their local and national representatives and senators about environmental problems. Group 1 could compose a letter to one senator; Group 2, a letter to a local representative.

Program D: "Today we made a new city. It wasn't made in a day."

Interaction:

1. Design a model city emphasizing sound environmental concepts (proper waste disposal, aesthetics, etc.) Utilize student resources for this. (Students can bring the shoe boxes and jars for buildings, toy figures for people, and various models for modes of transportation.) This is a major group activity and should be planned in advance. Local furniture stores or swimming pool contractors may give you the necessary cardboard.

2. Ask students to begin an environmental scrapbook about Phoenix. Collect newspaper articles and pictures specifically about the environmental problems of Phoenix.

Program E: "I never let my schooling interfere with my education." (Mark Twain)

Interaction:

1. Collect some litter that you have found on your school grounds. Glue this litter on poster boards and write where it was found. Display the posters throughout the school.

2. Make "Vista Points" on your school grounds. Have your students decide where some ideal viewpoints are located on your school grounds. Prepare an illustration with labels and place these at different points around the school.

3. Compose your own homeroom "Environment Song." Take a familiar tune (Yankee Doodle) and add new words. Relate it to the environment.

Program F: Municipal Parks. "Let's climb Squaw Peak to see the smog."

Interaction:

1. Request information from the Parks and Recreation Department about their programs for children. The P&R Department of Phoenix will be more than willing to assist you. The Department is one of the finest of its kind in the United States.

2. Ask your students to scout around for an empty lot in the neighborhood. Could this possibly become a temporary or permanent park?

3. Tour Encanto Park; observe the wildlife. Note any degradation of the park and bring this to the attention of the park's director. Observe how the plants and animals have adapted themselves to this contemporary paradox--a man-made natural environment.

Lesson 5: "If we choose to be plagued by big nightmares, we are entitled to offset them with equally big daydreams." (Ecotactics 1970)

Program A:

Take your students outside. Have each pick-up a fallen leaf from a tree and examine it. Some students may want to pick a living leaf from a branch. Allow the students to be by themselves to answer a few questions about the leaf. For example, what do the students perceive about the leaf? How is this one leaf important to them? What happens to the leaf after they have finished with it? What are the aesthetics of a leaf? Of a tree? Of a community? Of a city?

Resources:

Film, "Ark" Arthur Barr Productions, Inc., 16mm/20 mins./color